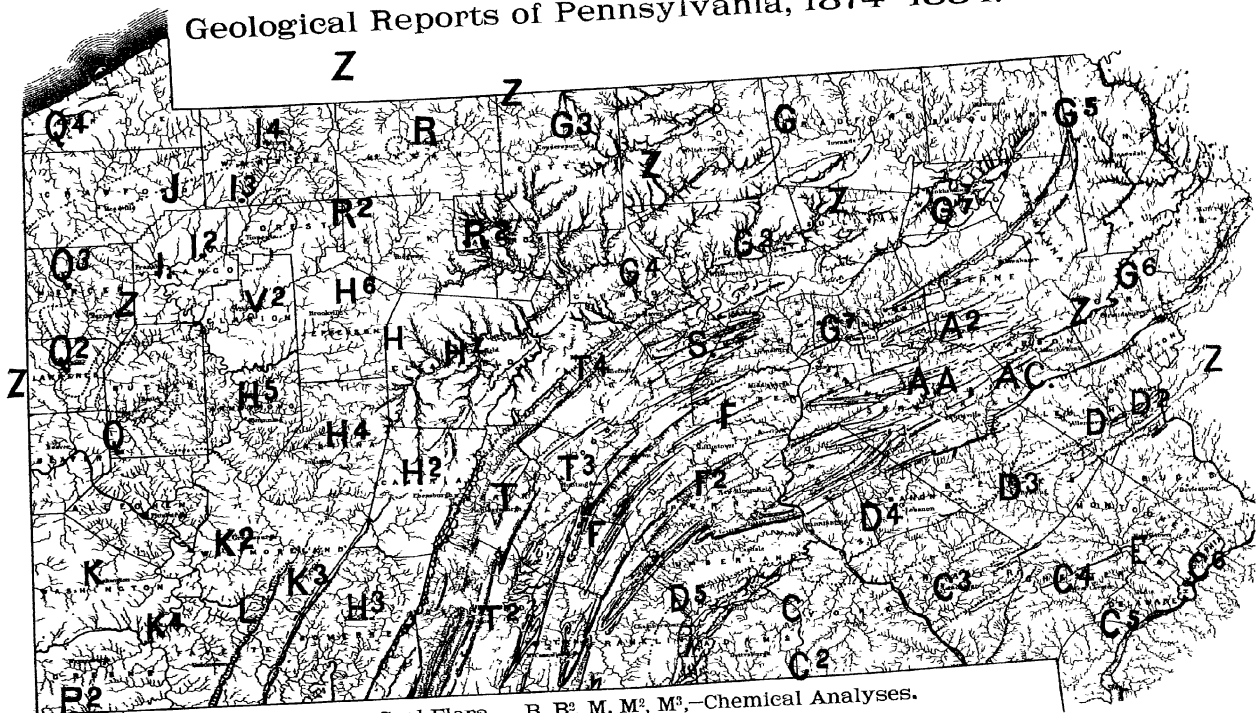

P.—Coal Flora. B, B², M, M², M³,—Chemical Analyses.
N.—Levels. O, O²,—Catalogue of Specimens.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.

REPORT OF PROGRESS H⁷.

A REVISION

OF THE

BITUMINOUS COAL MEASURES

OF

CLEARFIELD COUNTY.

BY H. M. CHANCE.

WITH A COLORED GEOLOGICAL COUNTY MAP; OUTCROP MAP OF THE HOUTZDALE BASIN; AND COAL BED SECTIONS IN THE TEXT.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1884.

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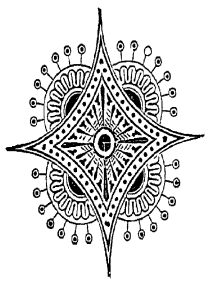


LETTER OF TRANSMITTAL.

To His Excellency, ROBERT E. PATTISON, *Governor of Pennsylvania, ex-officio Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania:*

SIR: I have the honor to submit the results of a revision of the geology of Clearfield county by Dr. Henry Martyn Chance, ordered by the Board.

The first survey of the Clearfield and Jefferson county coal fields was assigned to Mr. Franklin Platt in July, 1874, at the beginning of the State Survey. It was carried on, with an untrained corps, over too large an area to do it justice; less than two months being allowed for Clearfield and Centre, two months for Jefferson and Clarion, and one month for local examinations in Forest and McKean counties. It was, in fact, a tentative effort to organize and place in working condition a proposed detailed survey of the whole Bituminous Coal Region of Western Pennsylvania. The results, when published as Report of Progress H, were unsatisfactory, and it was arranged that when a proper occasion came, in the progress of the general survey of the State, an entire field-season should be given to Jefferson county, and that a revision of Clearfield county should be made. Jefferson county was therefore surveyed by Mr. W. G. Platt in 1880 (Report H^6), and now Clearfield has been revised by Dr. Chance, with all the advantage that his experience in Beaver, Lawrence, Butler, Clarion, Venango, and Warren counties gave him, and also with the great advantage of a large accumulation of recent knowledge produced by the active opening up of the region to the north-

ern markets, by reason of which the geology of Clearfield county has put on a new aspect.

A large part of the county is still a wilderness. Rocky "Barrens" stretch in various directions. The river valleys are, in fact, gorges or cañons, the streams meandering at a depth of 500 feet, more or less, beneath the average surface of a rolling table-land, the highest places of which are about 2000 feet above sea-level.

The geological formations of the region consist of the shales, sandstones, and conglomerates of the Coal Measures. They lie so nearly in their original horizontal condition, that dips in any direction cannot be observed by the eye,* but must be calculated by leveling from one exposure to another over considerable intervals.

The coal beds are only ten in number; eight of them being included between two great sandstone formations, the *Mahoning sandstone* above, and the *Homewood sandstone* below.†

These eight coal beds are lettered (from below upwards) ‡A, A′, B, C, (X,) C′, D, E; and, as they vary in thickness and lie within from 20′ to 40′ of each other, it is by no means an easy task to trace them individually across country, except where mining operations are large and numerous. In many townships several of these beds are still mistaken for one another.

Great assistance in identification is afforded by the Upper and Lower Freeport limestones, and the Johnstown Cement bed §; and also by the Clarion sandstone. But where the limestones fail, or are too thin to attract attention, or are in the wilderness, and where the sandstone turns into shale, it becomes next to impossible for the prospector to tell when he opens an outcrop, which one of the Kittanning or Freeport coals he has hit upon.

*See figure on page 80.

†The upper member of the Pottsville Conglomerate Formation, No. XII.

‡A, Brookville; A′, Clarion; B, Kittanning Lower; C, Kittanning Middle; (X,) Gorman; C′, Kittanning Upper; D, Freeport Lower; E, Freeport Upper.

§ The total absence of the *Ferriferous Limestone* (over bed A′) of western Pennsylvania, is a misfortune for the explorer of Clearfield county.

The geologist must place his main dependence, therefore, on the great *Mahoning sandstone* at the top, and the great *Homewood sandstone* at the bottom of the series; for these mark the country in an unmistakable manner; and the eight coal beds lie in the interval of say 300′ between them.

But the *Mahoning SS.* and the *Homewood SS.* resemble each other; and impress upon the surface of the country similar features, producing rocky "Barrens" of many miles extent—wilderness highlands, from which the small streams descend through ravines between cliff walls.

Were the geological formations of the region *absolutely* horizontal, there would be no difficulty in distinguishing between these two sand rocks; the spirit-level or the aneroid barometer would at once tell the explorer on which of them he stood; for, if the top of the Mahoning SS. ranged horizontally at 2000′ above tide, the Homewood SS. could be found by descending the valleys to about 1600′ A. T.

But western Pennsylvania is traversed by wide, gentle parallel anticlinal waves, the axes of which, although curved on a large scale, are nearly straight lines on any one county map. Basins lie between the waves.

The two great sandrocks, like all the other measures, rise and pass over these anticlinal axes and fall into the synclinal troughs; and the rise from the bottom of a trough to the crest of an anticlinal, and the fall again to the bottom of the next trough, although so gentle as hardly to be perceptible to the eye, amounts nevertheless to hundreds of feet.

But, besides this north-west south-east rise and fall from one basin to another, there are still gentler but decided variations of level *along the troughs and along the anticlinals* in a north-east and south-west direction.

All this makes it impossible to tell beforehand at what level above tide either the upper (*Mahoning*) sandstone or the lower (*Homewood*) sandstone will be found lying.

The consequences of this uncertainty, in the absence of sufficient means for exploration in past years, have been the gravest mistakes respecting the identity of these two sandstones; and whole townships of Clearfield county have been

condemned for colliery purposes on the misconception that their "Barrens" were produced by the *Homewood SS.* coming to the surface where, as is now known, the *Mahoning SS.* makes said "Barrens,"—the Homewood SS. being 400 feet underground, and of course all the coal beds being there.

This will explain the principal defects of the first report on Clearfield county (H, 1875) and the principal value of this second report by Dr. Chance.

The districts of the county affected by this revision are the highlands of the southern, western, and northern townships, bordering on Cambria, Indiana, Jefferson, and Elk counties.

1. At Janesville, in Gulich township, in the south-east corner of the county, the *Mahoning SS.* caps the hills, and the coal beds along Muddy run are mined underneath it. In Report H it was mistaken for the *Homewood* (Conglomerate No. XII), and the district was therefore supposed to be destitute of productive coal beds.

2. Around Houtzdale, in Woodward township, bed D was mistaken for bed B.

On the outcrop map of Houtzdale-Phillipsburg basin, in the pocket of this volume, Dr. Chance has traced the outcrop of this important coal bed (D, Lower Freeport bed) along the valleys of Whiteside, Beaver, Little Beaver, Coal, Mapleton, Decatur, and other runs, flowing into the Moshannon from the west, along the Houtzdale-Osceola Phillipsburg valley, with all the mines at present opened in it, the railroad branches by which their outputs are sent to market, and the elevations above tide-water at the mouths of the mines, by which an accurate idea of the lay of the bed in the basin can be obtained. The faulted condition of the bed at many points, as described in the text of the report, is also plainly exhibited on the map.

The hypsometrical data used in constructing this map we owe to the recent accurate surveys of the basin made by Mr. C. S. d'Invilliers and others.

3. In Chest township the high barrens between Crest creek and Clearfield creek, passing over into Cambria county, are made by the *Mahoning SS.*, and the coal beds

are underneath. In Report H the mistaken view was taken that here the great First or Laurel Hill axis had so elevated the Conglomerate as to remove all the coal beds.

4. In Burnside township, in the south-west corner of the county, there is an uncommonly steep S. W. dip towards Cherry Tree, which brings the Mahoning SS. from the top of the ridge down to within between 50′ and 100′ of river level at Cherry Tree. When the county map was colored the lower outcrop was supposed to be the Conglomerate No. XII. The mistake can be corrected on the map by stopping the No. XII color somewhere between Cush P.O and Burnside, and bringing the D bed color line to the river above Patchinville.

5. In Bell township, on the Indiana line, the *Mahoning* barrens were wrongly ascribed to the *Conglomerate*, and the district condemned; whereas all the coal beds underlie it, in spite of their elevation on the back of the Second (Chestnut Ridge) axis.

6. The whole north-west corner of the county was condemned in like manner by a like mistake, its barrens being supposed to be *Conglomerate;* whereas the *Mahoning* covers a great area in Brady, Union, and Huston, protecting all the coals in the great Third Coal Basin, one of the most important in the county.

7. The coal basin of lower coals in Northern Goshen and Girard townships, on the Elk county line, is a new feature described in this report.

Valuable extracts from Report H have been reprinted in this report H⁷ to enhance its value, so that no one need feel himself under the necessity of procuring Report H if he does not already possess a copy. Such extracts consist of special descriptions of mines, analyses of coals, cokes, limestones, and iron ores, and of Mr. Platt's description of the marketable fire clays, to all which no important additions can be made.

The new *Gorman Coal* (X) introduced into the Kittanning group (between C and C′) as a persistent member of the series was so named by Mr. W. G. Platt in Indiana county, (See H⁴, p. 220).

The tables of levels, railroad and miscellaneous, inserted by Dr. Chance at the end of Chapter I, pages 7, 8, and 9, merely furnish a basis for a system of levels which will soon extend widely through the county; for, great activity is manifested by railroad and coal companies planning and executing routes from the more valuable coal areas to the market of the north and east. It is very desirable that engineers and others who possess lines of levels should forward copies of the same to the office of the Geological Survey for publication.

The value of levels of individual mine openings and small branch roads to such openings is also considerable not only for engineering but for geological purposes, and all such levels should be collected for publication.

The geological use of such data may be seen on many pages of this report, numerous levels are given of outcrops of coal beds and also of the top or bottom of sandrocks obtained by Dr. Chance by means of an aneroid barometer, and from the data so obtained he was able to determine the anticlinal and synclinal structure, the rate of dip and the identification of coal beds, not otherwise determinable. Many of these occasional levels are given in the index, and all of them will be used in a future publication of the Levels of Pennsylvania.

With great respect,

Your obedient servant,

J. P. LESLEY.

1004 CLINTON ST., PHIL'A, *Jan. 24, 1884.*

LETTER OF H. M. CHANCE, M. D.

To Prof. J. P. LESLEY, *State Geologist:*

SIR: I present herewith my report on the revision of the geology of Clearfield county, with a map of the outcrop line of Bed D in the Houtzdale-Philipsburg basin, and a map of the whole county—colored to show the areas of barren Conglomerate, the areas occupied by the belt of the Productive coal measures, and the areas of Mahoning sandstone and *Barren measures*. I have defined these areas as well as I could in the space of time allotted to me, viz: from the second week of July to the end of the field season of 1883; which, although too short to permit of my visiting all the coal openings in the county, was, nevertheless, sufficient for subdividing the country broadly into said areas. My map, therefore, must be regarded as showing, only in a general way, "the lay of the coal" throughout the county; which is one of the largest in the State, (nearly 1200 square miles), to examine which in minute detail would certainly require at least two field seasons.

In my survey I received much assistance from Mr. C. S. d'Invilliers, Mr. C. Lingle, Mr. Wm. Wigton, and Mr. D. D. Dodge, of Phillipsburg; from Mr. Miller and Mr. Zentmeyer, of Houtzdale; from Mr. George Brisbin, of Osceola; from Col. G. H. Platt and Mr. Mark Hopkins, of Peale; from Mr. I. A. Harvey, of Beech Creek; from Mr. Ford, Supt. Bell's Gap RR., of Bell's Mills; from Mr. John Fritz, of Hazleton; from Mr. W. W. Seaman, of Tyrone; from Messrs. R. H. Sanders and Wm. G. Platt, of Philadelphia; and from many other gentlemen within the limits of the county.

I am, sir,

Very respectfully, yours, &c.,

H. M. CHANCE.

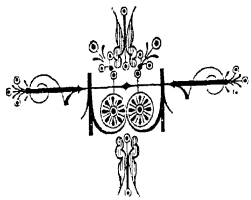


TABLE OF CONTENTS.

Part II.

Geology by Townships.

REPORT H7.

THE GEOLOGY OF CLEARFIELD COUNTY.

PART I.

GENERAL GEOLOGY.

CHAPTER I.

Geographical and Topographical Introduction.

Clearfield county lies south of Elk and Cameron counties, west of Clinton and Centre counties, east of Jefferson and Indiana, and north of Cambria county. It is therefore entirely west of the escarpment of the Allegheny mountains.

Its area is said to be about 1175 square miles. With the exception of a small area in the northwestern part of the county, the drainage is eastward through the West Branch of the Susquehanna to the Atlantic ocean; but this small area in the northwestern part of the county empties its waters into the Mahoning, an affluent of the Allegheny, which empties through the Ohio and Mississippi into the Gulf of Mexico.

The West Branch of the Susquehanna river enters at the extreme southwestern corner of the county, and flows northeast in an irregular and extremely tortuous course, leaving the county at its extreme northeastern corner. Its principal affluents in Clearfield county are Chest Creek, Clearfield Creek and Moshannon Creek.

Clearfield Creek rises in Cambria county, and enters Clearfield county in Beccaria township. It flows in an irregular and tortuous northeast course to Madera, at the mouth of Muddy Run, and thence in a nearly north course to its junction with the West Branch of the Susquehanna near Clearfield. Its principal affluent is Little Clearfield Creek, which rises in Ferguson and Jordan townships and flows in a northeast course, rudely parallel to the course of the West Branch of the Susquehanna.

The elevation of this creek at the mouth of Witmer Run in Beccaria township is about 1350 feet above tide. Its mouth is about 1075 feet above tide, thus showing a fall of 275 feet. Its total fall from the Cambria county line is probably in the neighborhood of 325 feet, or an average of about 10 feet per mile.

The Moshannon forms the eastern boundary of the county, separating it from Centre county. Its elevation at Osceola is about 1440 feet above tide, and at its mouth about 870 feet, equivalent to a fall of about 18 feet per mile.

Its principal affluents in Clearfield county are the Big and Little Beaver Runs.

Chest Creek is quite an important tributary to the West Branch of the Susquehanna. It rises near Ebensburg.

Anderson Creek, Moose Creek, Lick Run, Trout Run, Deer Creek, Sandy Run and Musquito Creek are the principal tributaries flowing into the West Branch of the Susquehanna from the north and northwest.

The lowest point in the county is the surface of the water in the West Branch of the Susquenanna where it leaves the county, at about 850± feet above tide.

A straight line drawn from Cherry Tree where the West Branch enters the county, to the point below Karthaus where it leaves the county, measures about 50 miles, but the river runs such an extremely tortuous course that the distance traveled by logs between these two points is nearly 100 miles.

The average height of summit or plateau land near the Susquehanna, and between the Susquehanna and the Moshannon, is from 1600 to 1800 feet above tide. The higher

ridges sometimes reach 1900 feet and in some localities land over 2000 feet above tide extends over considerable areas. A few high knobs exceed 2100 feet, in one or two cases nearly reaching 2200 feet above tide.

The Big Knob in Girard township is commonly considered to be the highest point in the county. It has been reported as (Caldwell's Atlas) 2280 feet above tide. My barometric measurement made it some 50 feet less.

The high ridges west from Wallaceton and Blue Ball considerably exceed 2000 feet above tide.

A large area of high land is found in the northern and northwestern part of the county, between the Low Grade Railroad and the Susquehanna, much of which is 2000 feet above tide. This dividing ridge at some points reaches 2200 feet above tide, but its summits are commonly between 2100 and 2150 feet. My barometric measurements along the Clearfield and Rockton road make the summits considerably over 2200 feet above tide.

Agriculture. The Productive coal measures and Barren measures generally make fair farm land, but when the Mahoning sandstone is present in force a considerable percentage is too stony to be cultivated. At the site of the Clarion sandstone tolerably good land sometimes occurs, but the cultivated land is commonly found above this horizon.

The Barren measure soil is commonly lean and poor and sadly in need of lime.

Within the last few years, the farmers have very generally begun to use the phosphate and ammoniated fertilizers, and with most promising results. Some, however, do not think they are of much benefit in growing corn.

It is questionable whether the more general use of lime, supplemented every three or four years by the application of phosphate fertilizers might not give as good or better results than the exclusive use of the latter. Lime is not largely used because its cost delivered by the railroad from Nittany valley, when added to the cost of haulage from the railroad, is almost equal and sometimes greater than the cost of a single application of a phosphate fertilizer.

But it should not be forgotten that lime is more lasting in its effects, and that when applied in sufficient quantity will give strength to the land for several years. It would be interesting to note the results obtained by liming thoroughly say once in six years and using a phosphate fertilizer once every three years.

However, as there are few farmers at present disposed to use lime, the use of the phosphate and ammoniated fertilizers should be encouraged, as most of the land needs far more enriching material than can be supplied by barn-yard manure.

Lumbering. The lumber industry has been the main factor in peopling and settling this county, but the most valuable timber has been cut, and there is comparatively little now standing that will compare in quality with that cut in former years. The pine timber now standing will soon all be cut if the output continues at its present rate, and a few years will see the practical death of the industry.

Of hemlock there is yet a very large quantity,—enough probably to last until the next generation.

As timber lands have increased in value with the reduction in the available supply, the wholesale waste of timber, (sometimes cut only for its bark,) has been stopped, and timber that a few years since would have been allowed to rot on the ground, is now shipped to market.

Towns. The county seat is at Clearfield, which is situated on the West Branch of the Susquehanna river near the center of the county.

Curwensville is a thriving town a few miles from Clearfield.

DuBois is located on the Low Grade, or Bennett's Branch railroad.

These towns have both acquired considerable importance from the lumber business.

Osceola on the Moshannon, and Houtzdale on the Beaver Branch railroad are both towns that owe their rapid growth to the development of the Houtzdale-Phillipsburg coal basin.

These are the principal towns of the county, and are all growing rapidly.

Phillipsburg, although located in Centre county, is a point at which much of the business connected with mining in Clearfield county is now transacted. It owes its prosperity almost entirely to Clearfield county, and gives promise of rapid growth in the future.

Population. The population of Clearfield county is given by Caldwell as follows:

Year.	*Population.*
1810,	875
1820,	2,342
1830,	4,803
1840,	7,834
1850,	12,586
1860,	18,759
1870,	25,741
1880, Compendium U. S. Census, Vol. I, p. 269,	43,208
Burnside . . . . borough in 1880 had	279
Clearfield . . . . " " "	1,089
Curwensville . . " " "	706
Lumber City . " " "	298
New Washington " " "	280
Osceola . . " " "	1,253
Phillipsburg (in Centre county) had	1,779

Railroads. The county has five railroads, and in a few months a sixth will have been added. However, as their total mileage, including branches, is somewhat less than one hundred miles, and of this some twenty miles or more are on local coal laterals, it will be seen that the county is as yet poorly supplied railroads. Seventy miles of main lines in a coal county of 1175 square miles is not much.

Tyrone and Clearfield Railroad. This is a branch of the Pennsylvania Central Railroad. Leaving that line at Tyrone, it has its present terminus at Curwensville. It enters the county between Osceola and Phillipsburg, but immediately recrosses into Centre county at Phillipsburg, crosses back into Clearfield county, and runs north-west to Clearfield on the West Branch of the Susquehanna. The traffic passing over that portion of this line in Clearfield county has been lumber, fire-clay, and general merchandise. As no mines shipping coal to market have yet been

opened on this line north-west of Phillipsburg, in Clearfield county, very little coal is passed over this part of the line. From Clearfield it runs south-west up the West Branch of the Susquehanna to Curwensville. It is now being extended west to open up the coal-fields of Penn township. The coal traffic of this line all comes upon the line on the Centre county side of the Moshannon Creek. On the map of the Houtzdale-Phillipsburg basin, the numerous branches of this road are plainly shown, and the location of the collieries from which they transport the coal.

These branches are:

1st. The Morrisdale Branch and its extension up Hawk Run.

2d. The Derby Branch R. R.

3d. The Mapleton Branches.

4th. The Beaver Run or Houtzdale Branch R. R.

5th. The Moshannon Extension.

Houtzdale Railroad.—This runs from Coal Run Junction, through Houtzdale, to Ramey. It has several branches:

1st. The Coal Run Branch.

2d. The Goss Run Branches.

3d. The Branch to the Houtz collieries.

4th. The Ramey Extension to the Wigton mines.

Bell's Gap Railroad. This is a narrow-guage railroad entering the county from the south, and, passing through Utahville, has its present terminus at Irvona, on Clearfield Creek. It has recently been changed to a broad-guage road.

Karthaus Railroad. This road has just been built. It runs from Keating, on the Philadelphia and Erie Railroad, in Clinton county, up the West Branch of the Susquehanna to Karthaus.

Low-Grade, or Bennett's Branch Railroad. This road passes across the north-western corner of the county. Entering at Tyler's, it runs up Bennett's Branch of Sinnemahoning Creek to the Summit; thence down Sandy Creek to Evergreen, where it leaves the county.

Rochester and Pittsburgh Railroad.—This road passes through the northwestern corner of the county. It fur-

nishes an outlet from Punxsutawney, in Indiana county, to Central and Western New York.

Beech Creek Railroad.—This road will enter the county in Morris township and run west or south-west.

It is unnecessary, and at the same time impossible, to here give a description of the many projected roads and extensions that have been surveyed and partly located in this county. By the time this report is printed and ready for distribution new roads or branches may have been built, but so much uncertainty always attends enterprises of this kind, that it would be a waste of time to describe any railroad not actually built.

By reference to the county map it will be seen that there is no railroad communication between the south-eastern and north-western parts of the county. Goods and passengers to be transported from Clearfield or Curwensville to Du Bois must travel overland about nineteen miles, or go around by rail six or eight times that distance. A railroad connecting Curwensville and Du Bois would be of inestimable benefit to the county.

Railroad Levels.

The following railroad levels are taken mainly from Report N. They are supplemented by other levels furnished by Mr. C. S. d'Invilliers, of the Pennsylvania Railroad:

Low Grade, or Bennett's Branch R. R.

Caledonia Tunnel, east end,	1148
Tyler,	1232
Penfield,	1289
Winterburn,	1348
Summit Tunnel,	1466
Shaffer's,	1425
Slab Run,	1405
Falls' Creek Bridge,	1405
Evergreen Water Station,	1398

Tyrone and Clearfield R. R.

Tyrone,	900
Summit, (Allegheny mountain,)	2036
Sandy Ridge,	1908
Powelton, (door sill of station,)	1772

Osceola, (S. end of door sill,)	1486
Mapleton Junction,	1448
Philipsburg, (S. end of door sill,)	1427½
Derby Junction,	1416
Blue Ball,	1540
Shimmel's,	1634
Wallaceton,	1722
Turner's Summit,	1735
Moravian Run,	1731
Ross Summit,	1744
Small's Summit,	1704
Camp Hummel,	1675
Bigler Station,	1655
Woodland,	1465
Roaring Run,	1420
Leonard's Point,	1299
Clearfield Creek, (Bridge?)	1133
Shaw's Run,	1105
Liberty Spring,	1096
Clearfield,	1096
Goodfellow's bridge,	1103
Spackman's bluff,	1110
Susquehanna River, (bridge?)	1117
Hogback,	1119
Hartshorn's Run,	1125
Curwensville,	1134
Anderson's Creek Crossing,	1144
Anderson's Creek, 2d Crossing,	1159
Bridgeport,	1183

Miscellaneous Levels.

Houtzdale,	1508
Kendrick,	1546
Ramey,	1600
Morrisdale town, at blacksmith shop,	1613
Kylertown Cross Roads,	1645
Confluence Big and Little Muddy Run,	1335
Confluence Muddy Run and Clearfield Creek, near Madera,	1316
Clearfield Creek, near Glen Hope,	1339
Turnpike crossing, Big Muddy Run, 1½ miles west of Janesville,	1359
Moshannon Creek, at crossing of Snowshoe road,	982
Moshannon Creek, at mouth of,	845
Susquehanna river, mouth Basin Run,	907
" " " Alder Run,	922
Abutment Clearfield Bridge,	1160
Clearfield Creek, surface water at "Clearfield Bridge,"	1144
Camp Hope Run, mouth of,	1187
Upper Morgan Run, mouth of,	1279
Witmer Run, mouth of,	1352
Beaver Run, mouth of, (?)	1444

Bear Run, mouth of, (?)	1467
Mountain Branch, mouth of, (?)	1485
Whiteside's Run, mouth of, (?)	1488
Wilson's Run, mouth of, (?)	1633

Bell's Gap Railroad.

Mr. R. G. Ford, superintendent of the Bell's Gap Railroad, has kindly furnished the following elevations along the line of his road:

	Above P. R. R. at Bell's Mills.	*Above Ocean.*
Mouth of mine at Lloydsville,	1120.6+1060=	2180
Summit, 1½ miles beyond Lloydsville,	1190.2	2240
Clark's Bridge,	950.0	2010
Mountaindale,	905.0	1965
Glasgow,	712.0	1772
Utahville,	606.0	1665
Coalport,	345.2	1405
Water of Clearfield Creek,	299.2	1359

CHAPTER II.

General Geology.

Clearfield county lies entirely behind the escarpment of the Allegheny mountains and therefore shows only the outcrops of Carboniferous and Sub-Carboniferous rocks. The Devonian and Silurian formations are deeply buried beneath its surface.

Enumerating the formations from above downward, we find in Clearfield county:

1st. The Barren measures, which form the highest land in the deeper portions of the First, Second and Third coal basins;

2nd. The Lower Productive coal measures, which spread out over a large area, forming the surface of probably three fourths of the 1200 square miles embraced within the county limits;

3rd. The Conglomerate measures, or No. XII. This formation forms the barren highlands north of the Susquehanna

river. It also crops out along the valleys of the Susquehanna river and its tributaries;

4th. The Mauch Chunk Red Shale, or No. XI, which is above water level along the Susquehanna and Moshannon, and

5th. The Pocono Sandstone, or No. X, the top of which is above water level for a short distance along the Susquehanna and Moshannon.

The Pennsylvania scheme of the Palæozoic formations is given below. It shows what rocks underlie those exposed above water-level. The thicknesses given are those observed along the Pennsylvania railroad, by Mr. Sanders.

	Barren measures.	
	Lower Productive Coal measures,	330′ to 360′
No. XII.	Pottsville Conglomerate, ...	200′ to 300′
No. XI.	Mauch Chunk Red Shale, "say"	100′, 283′
No. X.	Pocono Grey Sandstone, ...	1274′
No. IX.	Catskill Red Sandstone, ...	2560′
No. VIII.	Chemung Shales, ...	6519′
	Portage Flags, ...	
	Hamilton, ...	
	Corniferous Limestone, .	
No. VII.	Oriskany Sandstone, ...	50′
No. VI.	Lower Helderburg: Limetones, Marls, etc., ...	900′
No. V.	Clinton Red Shale, ...	1328′
No. IV.	Media Sandstone, ...	3236′
	Oneida Conglomerate, . . .	
No. III.	Hudson River and Utica Slates, . . .	900′
No. II.	Lower Siluro-Cambrian Limestones, .	6600′+
No. I.	Potsdam Sandstone,	

Persons inexperienced in drilling for oil, and many who have had more or less experience in the oil fields, but who are nevertheless misinformed as to the nature of oil territory, the conditions under which oil exists beneath the surface in paying quantities—in other words, the geology of petroleum—or being correctly informed as to these facts, but not being familiar with the geology of the rocks under-

lying this county,* have from time to time created local excitements by expressing a belief that oil exists beneath this district.

No geologist can positively assert that oil may not be found in some localities, neither can its presence be determined in advance of the drill. All "surface indications" are utterly worthless. This is abundantly proven by the fact that at hundreds of localities showing oil seeps and other "surface indications," the drill has shown an entire absence of oil beneath water level. "Surface indications" (oil seeps and springs) come from surface rocks, that is, rocks near or above water level, but rocks so located have never been found productive in paying quantities.† As very few now advance the argument that because oil exists in small quantities in the surface rocks, those at great depth will be found loaded with it, it is unnecesary to show why such reasoning is fallacious.

A discussion of this subject might be extended over hundreds of pages, but is entirely unnecessary here because anyone can obtain for himself a knowledge of the geology of petroleum from Mr. Carll's Reports I, III and I⁴, after perusing which, an examination of the lower rocks as exposed along the Allegheny escarpment by railroad cuttings will furnish convincing proof that the formations do not there consist of rocks that would make good oil reservoirs, nor do they show much evidence of holding oil even in small quantities.

The crimpled and disturbed condition of the measures in this area is another argument that may be advanced against the probable existence of oil in paying quantities. It therefore seems to me highly improbable that oil will ever be found in quantity within the limits of this county.

The Barren Measures.

These rocks are found only in a few districts of Clearfield county. They are found capping the high summits along

*These may be studied to advantage at their outcrops along the Allegheny escarpments and foot hills in Centre and Blair counties.

† Except in heavy (lubricating) oil districts.

the Bloomington ridge, south of Curwensville and Clearfield, and also in the trough of the Ansonville sub-basin. They cover a considerable area in Beccaria and Geulich townships.

The rocks of this series are readily recognized by certain peculiarities that are not easily described, but which are, nevertheless, in marked contrast to the shales and slates of the Lower Productive Measures.

The rocks of the lower part of the Barren measures are commonly of a light gray or lead color, and are eroded in smooth rounded knolls. They may be identified as belonging to the Barren measures, by

1st. Being found above a hard sandstone and conglomerate—the Mahoning—beneath which soft rocks with coal-beds are found for at least 180 to 200 feet.

2d. By the usual absence of valuable coal-beds, and thick beds of fire-clay.

3d. By the presence of one or two thin limestone beds a short distance above the Mahoning sandstone.

I did not compile a complete section of the 200 feet or more of Barren measures found in this county. The sections given by Mr. G. W. Platt in reports H,[2] H[4] and H[6], will be found to apply very well to these rocks in Geulich and Beccaria townships.

Only one important coal occurs in these rocks in this district. I am in doubt as to whether it should be called the Gallitzen or Philson bed. It is commonly from two to two and a half feet thick, but along Muddy Creek reaches, and in some places exceeds, three feet, thus becoming a valuable bed. It yields an excellent hard, black coal.

In the Third Basin the Barren measures are spread out over parts of Brady, Sandy and Huston townships.

Lower Productive Coal Measures.

These will be described in Chapter IV of this report.

Pottsville Conglomerate Series No. XII.

In Clearfield county conglomerates rarely predominate in the Conglomerate Series, which is for the most part com

posed of false-bedded sandstones and shales. The top rock of the series, immediately beneath the Blue Ball fire-clay, is often a coarse conglomerate. This is its character in many parts of Bradford, Graham and Morris townships. It is doubtless the Homewood Sandstone.

A coarse conglomerate, with pebbles sometimes as large as a walnut, sometimes occurs at the base of the series. It is seen along the lower part of the Susquehanna River. It may be considered as the representative of the Olean Conglomerate.

However, neither of these rocks exists as a conglomerate over a large area. They are both frequently replaced by sandstone, which may be massive and white, false-bedded, fine-grained and yellow, or even a shaly gray rock, while in many localities they are almost entirely replaced by shale.

A group of current-bedded sandstones and shales occurs between these two rocks. It may be recognized as the representative of the Connoquenessing Sandstones. Sporadic beds of coal, sometimes locally of workable thickness, are found in this group. Between the Homewood Sandstone, or upper member of the Conglomerate and the Connoquenessing Sandstone group, we find the attenuated eastern representative of the Mercer group of coals.

At a few localities along the Susquehanna and Moshannon a coal of workable size has been found at this horizon. It was worked many years ago, and the coal was shipped in arks to the markets in central Pennsylvania. These openings have long since fallen shut and the coal cannot be measured. It is reported as a three or four-foot bed.

At many localities along Clearfield Creek, and along the Susquehanna River and its main branches above Clearfield, this coal has been found at or near water-level. It is commonly not more than eighteen inches to two feet and a half thick.

I have not recognized the Sharon coal in this county. It is probably quite thin or entirely absent.

The thickness of the Conglomerate Series from the fire-clay under bed A, down to the Red Shale of No. XI, may be considered to range from 275 to 325 feet.

Mauch Chunk Red Shale No. XI.

I have not determined the thickness of this formation in Clearfield county. From its thickness in the adjoining counties we may consider it to range from 50 to 125 feet.

It is found above water-level only along the Susquehanna River and the Moshannon,* as shown by the Geological map, and its outcrop is so covered by debris from the Conglomerate measures that it is seldom seen and never well exposed.

The Geological Map.

It was not at first considered possible to collect the material for a report on so large an area, and at the same time to construct a map defining by colors the areas underlaid by the different coals. The great value of such a map, even if only approximately correct, has, however, induced me to attempt its construction.

The fact that all of the examinations have been made in a period of less than five months, and that the area covered is about 1200 square miles, much of which is unimproved timber land, will be a sufficient apology for its imperfections.

The method of coloring adopted in other counties has been slightly modified in order to show plainly the outspread of the Freeport coals (D and E). The darkest tint is intended to show the area underlaid by the Freeport Lower coal (bed D) and therefore embraces those areas containing the Barren measures.

The intermediate tint is intended to show the area underlaid by the remaining Lower Productive coals (from A to D); the lightest tint shows the Conglomerate measures, No. XII.

The red line shows the outcrop line of the Mauch Chunk Red shale, No. XI. As it always lies near stream level, it has not been thought necessary to give the underlying Pocono Sandstone rocks (No. X) an independent color. As there are doubtless many small areas of the Freeport

*And some streams in the mountainous area north of Clearfield where no good opportunity is afforded of studying it.

Lower coal that have not been located on this map, it should be clearly understood that their absence should not be construed as an absolute assertion that this coal does not exist. Reference to the text of this report will often be found serviceable as a check on the map.

In a general way the map may be considered to show the "lay of the coal" with a fair approach to accuracy. It plainly shows the great outspread of the upper coals along the course of the three great basins, the uplift of the Conglomerate along the anticlinal axes, and also the unbroken sweep of the coal measures over these anticlinals in the western and south-western portions of the county.

The omission of some areas of the Freeport coals has already been mentioned. It should also be remembered that in many localities the area of these measures as shown by the map is doubtless larger than would be shown by a more accurate survey. More or less difficulty was experienced from the inaccuracies in the map itself. This was made from Beer's county map, published in 1866, which probably shows the location of roads and towns with a fair approach to accuracy; but this cannot be said of the streams. These, especially the smaller streams, are often incorrectly shown, and this renders the construction of a colored map very difficult. It is always necessary to make the coloring "fit" the streams, and in so doing the shape and size of many of the areas of Bed D have necessarily been distorted. This will be seen at once by comparing the colored map with the special outcrop map of the Houtzdale-Morrisdale basin.

In the mountainous wilderness north of Clearfield the coloring can only be considered as a rough approximation to what a careful examination would develop. This district, embracing an area of about one hundred and fifty square miles, is without human inhabitants; is traversed by a few wood-roads, often impassable to wagons, and is principally occupied by rocks of the Conglomerate series, forming rocky sterile soil. Careful detailed examinations,—which can be made only by camping out in the woods—must be made before the areas underlaid by coal can be accurately defined.

My examination of this district was confined to four trips made on foot across the mountains at different points.

Division into Townships. The division of the county into townships, as represented on the map, is taken from the county atlas lately published by Caldwell. I have since been informed that this atlas does not show the townships correctly, as the boundaries have been changed to create two new townships since the atlas was published.

As my field work had been governed to some extent by the old township boundary lines, and my notes were written up in accordance with a system adopted from the start, and based on the township maps of Caldwell's atlas, I have thought it best to publish the manuscript and map as originally prepared.

Chapter III.

Structural Geology.

The First, Second, and Third Bituminous Coal Basins pass through Clearfield county in a general south-west and north-east course.

They are separated by two anticlinal axes, commonly known as the First and Second axes, the Third basin being separated by the Third or Boon's mountain anticlinal from the Fourth basin of Jefferson and Elk counties.

Beginning at the south-eastern corner of the county, and passing north-west to Boon's mountain at the north-western corner of the county, we pass over the following axes and basins, which will be described in this chapter in the same order.

First Basin.
- Eastern sub-basin (?)
- Gulich township sub-anticlinal (?)
- Utahville-Ramey-Houtzdale-Osceola-Philipsburg-Morrisdale basin.

First Anticlinal Axis—Laurel Hill axis.

Second Basin.
- Ansonville sub-basin—Karthaus basin.
- Marion sub-anticlinal—Nolo axis of Indiana county.
- Pennville sub-basin.

Second Anticlinal Axis—Chestnut Ridge—Driftwood axis.

Third Basin.
- Eastern sub-basin.
- Second sub-anticlinal.
- Du Bois—Benezette basin.

Third Anticlinal Axis—Boon's Mountain axis.

The First Basin.

The approximate position of the central line or axis of this basin is marked by a dotted line on the Geological map. As it is described in detail in chapter V, it is not necessary to duplicate that description here.

It will be seen that the *central line* of this basin is not continuous with the Snow Shoe trough.

In Gulich township it is apparently double, a small sub-

basin coming in from Cambria county which is separated from the main trough by an anticlinal roll. This is the only construction admissible if we identify the coal openings on Whiteside run with the Moshannon bed (D), and it is also rendered probable by the recent discoveries made by the Kittanning Coal Company south-west from Ramey.

While I have not been able to locate this sub-anticlinal with any degree of accuracy, I feel reasonably confident of its existence. If this hypothesis is rejected we are forced to assume the presence of an extensive fault to account for the difference in level between coal openings on Whiteside run and the area prospected by shafts and drifts farther north-west.

Along the central line of the First Basin from Ramey, south-westwardly to the Cambria county line near Utahville, the high land is formed by the Barren Measures, which in the vicinity of the latter place extend almost down to water-level, thus burying the principal coal beds far beneath the surface.

The north-western boundary of the First Basin is indicated on the map by the line showing the axis or crest of the First Anticlinal, but we do not find that the dip is uniformily away from this axial line towards the center of the First Basin.

Northerly and westerly dips occasionally occur between the line of this axis and the center of the trough, and there seems to be at least one well-defined sub-axis in this area. This sub-axis passes near Amesville, where the coals dip towards Madera,* and the north dip will probably be found in the high lands at the head of Coal run, Crowell (Mapleton) Run, etc. It probably dies away to the north-east, or merges into the main anticlinal uplift west of Blue Ball.

The north dip of this sub-axis is shown by the openings on Bed B at Madera, but this dip continues only for a short distance, when the prevailing rise to the north-west reasserts itself and lifts the top of the Conglomerate, No. XII, high above water-level on Upper Morgan run.

Going south-west towards Coalport this *sub-axis* proba-

*Bed D is lower at Madera than at Amesville.

bly flattens out or entirely disappears. From where the line of the First Anticlinal crosses into Cambria county to Coalport there is a very strong east or south-east dip; but from Coalport east towards Utahville the dip is not so sharp.

I find that the significance of the lines marked upon geological maps to show the axial line of anticlinal uplifts is not understood by many persons. Some imagine a distinction is to be made between an "anticlinal" and an "axis;" that one brings up the conglomerate, No. XII, and throws the coals out into the air, while the other does not. Others suppose that this occurs where an "anticlinal" or an "axis" is marked upon the map. It is, therefore, proper to explain here that—

1st. An *anticlinal* is simply a fold or roll in the rocks, or a line along which they are uplifted.

2d. An *axis* is the central or crest-line of an anticlinal; in other words the line along which the *greatest uplift* is found. The term *axis* is often used synonomously with *anticlinal.*

By reference to the geological map it will be seen that along the south-western portions of both the First and Second anticlinals the coals ride over from one basin to the next, and that the Conglomerate is not brought up into the hills, but to the north-east. Both of these anticlinals bring the Conglomerate up into the hills and throw the coals up into the air.

The geological map shows the central line or *axis of the trough* of the First Basin terminating between and east of Morrisdale and Kylertown. North-east of this point the measures in Morris township appear to lie rather flat, but with a general dip towards the Moshannon creek. In other words, the basin does not appear to have any well-defined trough. The First Anticlinal axis is much flattened and apparently dying away, and the trough of the basin from Philipsburg to Morrisdale is rising and flattening—"*spooning out.*"

First, or Laurel Hill Anticlinal.

This axis enters Clearfield county in Chest township between Chest creek and the South Fork of Witmer run. The high dividing ridge which marks its site is 1,800 or 1,900 feet above ocean level, and is capped by the Mahoning Sandstone. All of the Lower Productive coals, therefore, ride over on the axis at this point.

It apparently runs in a nearly north-east course, crossing Witmer run about one mile and a half above its mouth, and can be easily detected in the high land two or three miles back of Glen Hope, where the coals lie higher than at Glen Hope, and are also higher than at Ansonville.

On Clearfield creek and Upper Morgan run, the top of the Conglomerate No. XII is lifted about two hundred feet above water-level by this axis, which apparently passes close to Jeffries cross-roads P. O., and thence north-east to the high land west of Blue Ball and Wallaceton, where the Conglomerate, No. XII, is raised in a dome-shaped uplift to a height of over 2000 feet above tide water.

The line of greatest uplift (the axis) here swings to the north, but soon again resuming its north-east course it crosses the railroad near Wallaceton and runs off into Graham township, passing near Centre Hill. It was last recognized at a point in Morris township near the head of Basin run, where the top of the Conglomerate shows at an elevation of 1500 feet, and on the road leading down to the mouth of the Moshannon. Mr. D'Invillier's work in Centre county will show this to be the continuation to the south-west of the Hyner anticlinal axis which crosses the West Branch of the Susquehanna near Hyner station. (See Report G⁴.)

The Second Basin.

In Report H⁴ this is described as a double basin by Mr. Platt, and as such it enters Clearfield county from Cambria and Indiana counties.

On the south-east its limits are plainly defined by the line

of the First anticlinal, while the mountainous axial line of the Second anticlinal clearly separates it on the north-west from the Third basin.

Between these two axes, which exhibit a marked parallelism, and which in a general way define the local drainage tributary to the Susquehanna, we find a third axis—the *Marion sub-axis*—which is doubtless the same with Mr. Platt's *Nolo anticlinal* of Indiana county.

Marion anticlinal sub-axis.—This enters the county from Cambria county, apparently occupying the high land near East Ridge, or between the cross-roads and the Cherry Tree. It was next detected on Chest creek south of Newburg, where it lifts the coals about one hundred feet higher than at Westover. It passes north-east, elevating the Mahoning sandstone to the top of the high land near Marion P. O. I found it almost impossible to locate this flexure with any degree of accuracy north-east from the latter point, but it is evident that it lifts the coals at Lumber City and between Pennville and Curwensville, for in this district, especially near the former place, the coals show a local dip towards the west. To the north-east it either fades away as an anticlinal axis, or merges with the Second anticlinal in the mountainous region north-west of Clearfield. As I found no well-defined north or west dips between Curwensville and Packersville, I am inclined to think the axis dies out before reaching the Luthersburg pike.

It therefore follows that while we find two well-defined troughs or basins in the south-western portion of this Second basin, we find this basin single from Curwensville northeast to Karthaus.

Ansonville-Bloomington-Clearfield-Karthaus Basin.

This is the main trough of the Second Basin in Clearfield county. It enters the county near Sommersville's, on Chest creek, and runs north-east through or close to Ansonville, where the summits carry a cap of Barren Measures, thence north-east, the line of greatest depression

probably passing along through the Bloomington ridge, south of the river. At Clearfield the central portion of the basin is quite flat; the trough may be considered as passing between the town and the mouth of Clearfield creek, continuing on in about the same course to near Shawsville, where it apparently bends to the right and runs almost due east,—its course being indicated by the average course of the river,—to near the mouth of Basin run, where it bends sharply to the left and runs north-east to the Clinton county line a short distance back from the river, passing through the great double bend in the river near the mouth of Moshannon Creek.

It is therefore continuous with the Round Island, Westport and Renovo Basin of Clinton county (see Report G⁴).

Pennville Sub-Basin.

This is the north-eastern extension of the western subdivision of the Second Basin in Indiana county (see Report H⁴). It enters the county from Indiana county, crossing the river near Burnside or the mouth of Cush creek, where Bed A is about (or a few feet below) water level, thence passing north-east it passes near New Bethlehem, crossing Chest creek not far above Mahaffey's mill, and again reaches the river near Lewisville, and passing close to Belleville runs north-east, until, at a short distance beyond (north-east of) Pennville, it apparently flattens out and disappears, its north-west dip giving way to the strong south-east dip away from the Second anticlinal axis.

Chestnut Ridge or Second Anticlinal.

This axis enters the county near the center of the Bell township line, and close to the junction of the Indiana-Jefferson county boundary with the Clearfield county line.

It runs in a north-west direction, passing through the south-eastern corner of Brady township and the north-west corner of Penn township, and crosses the Luthersburg-Curwensville pike between Bloom's run and Packerville.

It crosses the Clearfield and Luthersburg road near the head of Horn Shanty run, and the Clearfield and Pennfield road a short distance south-east of Smith's improvement. From this point it runs north-east, and crosses the old road leading from Goshen to the Caledonia pike, about half a mile from the Big Spring.

It sweeps across Goshen township in a more easterly direction, crossing the road to the Globb place about one mile south of that improvement. Thence north-east to the Cameron county line, to join the Driftwood axis as marked upon Mr. Ashburner's maps.

I am not thoroughly satisfied with the location and course of this anticlinal in Girard township as marked upon the map, but have so drawn it to make it fit with Mr. Ashburner's location of the Driftwood anticlinal, with which it is undoubtedly continuous. I think its true position is somewhat east of that shown by the map.

The Mahoning Sandstone is the rock found capping the dividing ridge along this anticlinal in Bell township, and all the coals therefore ride over from the Second into the Third basin; but as we approach Anderson creek the anticlinal crest rises rapidly, so that the Mahoning Sandstone soon shoots out into the air, and only the lower coals are found in the hills near Packersville. After crossing Anderson creek we find the Conglomerate measures have come up and form the high "Barrens" that extend in an unbroken line along this axis to the Cameron county line.

In the vicinity of Rockton, and as far south-west as Troutville, in Brady township, the north-west dip from this axis towards the central line of the Third basin is surprisingly abrupt.

Third Basin.

Before proceeding to a general description of the Third, or DuBois-Benezette basin, it is in place to mention briefly the existence of an anticlinal sub-axis that occurs between the Second anticlinal and Caledonia.

This axis elevates the Conglomerate high above the surrounding county in the area known as the "Caledonia Barrens." Between this area and the Second anticlinal a shallow coal basin is found. It is passed through in traversing the Caledonia pike from the Globb place westward to the "Caledonia Barrens." It contains a considerable area of Bed B, and a small area of Bed C', while Bed D may be caught in the highest knobs along the line of greatest depression.

The Third basin in Clearfield county is largely a region of Barren measures. Its central line apparently follows the line of the Low Grade Railroad from Tyler's south-west to within a few miles of DuBois, and then apparently leaves the valley to run under the high land near or south of West Liberty. It is a continuation north-east of the Punxsutawney coal field.

Third Anticlinal Axis.

This axis, as described by Messrs. Ashburner and Platt, should cross the extreme north-western corner of this county in a north-east and south-west direction.

Chapter IV.

The Lower Productive Coal Measures.

In some particulars the typical section of the Lower Productive coal measures in Clearfield county differs from that of Jefferson and other counties lying in the western basins.

Beginning at the top of the column, we find the Freeport Upper coal (E) generally lying closer to the Freeport Lower coal (D.) In Clearfield county this interval ranges from twenty-five to forty feet.

The Freeport Lower coal is here separated from the Kittanning Upper coal by an interval of from forty-five to fifty feet, while in the Allegheny river country this interval is often much larger. It there carries the Freeport Sandstone, a rock sometimes measuring sixty to seventy feet. In this district the Freeport Sandstone is always thin and sometimes it is entirely replaced by shale or slate.

The Kittanning Upper coal (C′) is here found at about the same intervals from the Kittanning Middle (C) and Kittanning Lower (B) coals as in the western part of the State, but the Kittanning series in Clearfield and in parts of Centre, Cambria, Indiana, and Jefferson counties contains an additional bed of coal that has not been named or recognized as one of the regular series. Mr. Platt provisionally calls it the "Gorman coal." (See Report H⁴.)

This coal is found about midway between the Kittanning Upper and Kittanning Middle coals. It is rarely more than two feet thick.

The absence of the Ferriferous Limestone as a persistent stratum in this district apparently effects a reduction of the internal between the Kittanning Lower coal and the Conglomerate. Thus, in the western part of the State, we commonly find the intervals, as shown in the first column, and in this county as shown by the second column:

Kittannning Lower coal,	= Bed B.
Interval 40'.	
Ferriferous Limestone, 10'.	Interval 50' to 60'.
Interval 30'.	
Clarion Coal.	Bed A'.
Interval 30'.	Interval 20' to 35'.
Brookville Coal.	Bed A'
Interval 5'-10'.	Fire-clay.
Pottsville Conglomerate No. XII.	Conglomerate No. XII.

In some localities we find the whole interval from Bed B down to Bed A occupied by the Clarion Sandstone. In such cases the Clarion coal, Bed A', is cut out by the sandrock. This Clarion Sandstone, when present in force, singularly resembles the Homewood Sandstone. It is often massive and conglomeratic, and in some localities it is a true conglomerate with pebbles as large as a pea or perhaps larger. However, it is more commonly a rather friable yellowish sandstone, weathering down into a reddish or yellowish sandy soil, made more or less clayey by the heavy bed of fire-clay that frequently underlies Bed B, resting directly upon this rock.

A generalized section of the Productive Coal Measures in this district, therefore, shows intervals as in Fig. 1.

The section makes the average interval from the Kittanning Lower coal bed (B) up to the Moshannon or Lower Freeport bed (D); base to base, 128 feet. In the Houtzdale-Morrisdale region it ranges from 120 to 125 feet. On the Allegheny river the expansion of the Freeport Sandstone increases the interval to 160 feet or more.

In the Low Grade district and along the western edge of the county, as well as in some parts of the Second basin along the Susquehanna, there may be as much as 140 feet between these two beds.

In determining the relative commercial importance of different beds, we are naturally governed by their thickness, the quality of the coal, and the partings of slate, bony coal or fireclay they contain. The character of the floor is rarely of much importance, and if a bed is good in quality and thickness, its roof is seldom so weak that the bed cannot be profitably worked.

General Section, Fig. 1.

	Observed limits.	Average.
Mahoning sandstone—the top rock.		
Shales and slates, sometimes ferruginous,	20′ to 40′	30′
Freeport Upper Coal—E,	2′ to 4′	3
Fireclay, 2′ to 6′		
Shales with ore,		
Freeport Upper Limestone,	25′ to 40′	35′
Shales and slates, sometimes sandstone,		
Freeport Lower Coal—D,	2′ to 7	3½
Fireclay, 1′ 6″ to 4′		
Freeport Lower Limestone, 0′ to 4′	42′ to 50	47′
Shale—place of Freeport Sandstone,		
Kittanning Upper Coal—C′,	1′ 6″ to 5′	2′
Fireclay, 2′ to 4′		
Johnstown Cement bed, 0′ to 4′		
Shales and slate, (thin,)	30′ to 40′	35′
Coal—Unnamed, 0′ to 2′		
Fireclay, 0′ to 2′		
Shales and slate,		
Kittanning Middle Coal—C,	1′ 6″ to 3′	2′
Fireclay,		
Shales and slates,	35′ to 40′	38′
Sandstone, fine grained, tough,		
Kittanning Lower Coal—B,	3′ to 7′	4′
Fireclay, 4′ to 8′		
Shales, sandy, 55′		
Clarion Coal—A′, 1′ to 2′ — Sometimes occupied by Clarion Sandstone	70′ to 80′	
Fireclay, 2′ to 10′		
Shales, 20′ to 30′		
Brookville Coal—A,	0′ to 4′	2′
Fire-clay—brick-clay,	0′ to 10′	3′
Pottsville Conglomerate, No. XII.		

Quality—and by this we commonly mean a small percentage of ash and an unobjectionable percentage of sulphur,—is evidently a more important prerequisite than either thickness or the absence of partings; for a thin bed simply costs a little more to develop than a thick bed, and bony or slaty partings, if not too thick, can be separated in mining, and the coal then commands a ready sale. But if the coal itself is of poor quality, neither thickness nor the absence of partings, nor an exceptionally good roof, will enable the operator to offer it at a figure low enough to insure the sale of large quantities; for these conditions, be they ever so favorable, will not make a greater reduction than fifteen cents or

thereabouts below the cost of mining from beds of *good* coal of ordinary thickness; and this difference is not sufficient to warrant the purchase of the cheaper coal.

Assuming the average ash in a coal of A No. 1 reputation at 6 per cent., and the ash in a second grade coal at 11 per cent—a difference of 5 per cent—there should be a difference of 5 per cent or more in the price to the consumer to warrant the purchase of the inferior coal. Assuming the cost per ton (delivered) to the consumer at $3 00, a difference of 15 cents ($2 85) will not warrant the purchase of the cheaper coal, because it is a coal that will probably require more labor in firing, and that cannot be used as economically on account of the accumulation of clinkers in the grate bars, and at the same time it is a coal that contains more sulphur.

It is therefore evident that, as the cost to the consumer is governed by—first, the railroad freights; and secondly, the cost of the coal at the mine, and as he is paying freight on every pound of ash the coal contains, the difference in price at the mines between first-grade and second-grade coals can rarely warrant the purchase of the latter.

Having reference then to *Quality* first, we may inquire how the coals rank if compared by their ash and sulphur percentages. In Clearfield county I find two beds that commonly furnish coal of most excellent quality, viz: The Freeport Lower coal bed (D) and the Kittanning Upper coal bed (C'.) The Kittanning Middle coal bed (C)—also furnishes coal of good quality, but it rarely reaches or exceeds three feet in thickness.

Next in rank to these two beds we place the Freeport Upper coal bed (E.) This bed at times yields most excellent coal, but in some localities is quite sulphurous.

The Kittanning Lower coal bed (B) generally runs high in ash and sulphur. It does not yield a first-class coal.

The Brookville coal bed (A) is commonly a sulphurous and dirty coal.

If we require for remunerative mining a thickness of three and a half to four feet, then operations must necessarily be restricted to three beds, the Freeport Lower (D),

the Kittanning Upper (C′), and the Kittanning Lower (B), and to a few local developments of the Freeport Upper coal (E).

Freeport Upper Coal—Bed E.

This coal ranges from three feet and six or eight inches in the Morrisdale-Phillipsburg region to two and a half to three feet near Houtzdale. It is commonly two and a half to three feet thick in the Second basin, possibly approaching four feet in Karthaus township. In the high ridge south of Clearfield and Curwensville it sometimes reaches and locally exceeds three feet.

In the Houtzdale-Morrisdale district it is reported as a coal of excellent quality. It has been ruined by the workings on the Freeport Lower coal, thirty feet beneath it.

It cannot be considered of much importance in Clearfield county.

Freeport Lower Coal—Bed D.

This is the celebrated "Moshannon Vein." It nearly always yields a coal of good quality; but a few exceptional localities have been developed in which the coal is quite sulphurous.

It is of good workable thickness in parts of Gulich, Bigler, Woodward, Decatur, Morris, Karthaus, Girard(?), Goshen, Penn, Sandy, Brady, and Bell (?) townships, but the total area of this coal, outside the First basin, that has been proven of good workable thickness is quite small—probably only a few thousand acres.

In the vicinity of Clearfield and Curwensville it is commonly called a "two foot bed," sometimes swelling up to three feet. In Chest, Burnside, and Beccaria townships it averages probably less than three feet thick.

In parts of Geulich township it contains a bad parting that will greatly retard its development.

Kittanning Upper Coal—Bed C′.

This coal is generally quite thin and unimportant in the Houtzdale-Philipsburg district; but on the Clearfield creek

slope of the First basin the bed has been found in much better form. It has here been opened from three to five feet thick, but often contains one or several slate partings, and from this fact it is known to many as the "Slate Vein". But this name is applied by some to Bed B.

In the Curwensville, Bloomington and Ansonville district this coal reaches a thickness of three to three and a half feet, averaging about three feet and two or three inches, and furnishes coal of excellent quality. It is here the most important bed in the series. It is also probably of good workable thickness in parts of the Pennville district, and may be found workable in the area lying between this and the former region.

In Girard township, and in the eastern part of Goshen, it is in places a "four-foot bed," and is reported as attaining a thickness of three and a half feet or more in Karthaus township.

Two openings recently made on this bed at Westover, in Chest township, show over four feet of clean coal, so that we may feel some assurance of a workable area of some extent in that vicinity.

"Gorman" Coal.

This is never of workable thickness in Clearfield county. It seems to be a persistent member of the series in this county, lying nearly midway between the Kittanning Upper and Middle coals. It is commonly from one foot to one foot and eight or ten inches thick. The above provisional name is here adopted from Mr. Platt's report on Indiana county, H⁴.

Kittanning Middle Coal—Bed C.

This is commonly too thin for present working. Sometimes it is badly parted by sandstone, but when found in normal condition it is commonly about two feet thick. In Girard, Bradford, and Graham townships it often attains a thickness of three feet, and in some of the river townships above Curwensville from two and a half to three feet of coal have been found at this horizon.

In quality the coal from this bed compares favorably with that mined from any other bed; and when we come to mine coal ranging from two and a half to three feet thick, this bed will be much sought after.

Kittanning Lower Coal—Bed B.

The typical form in which this bed is commonly found in Clearfield county is a *double bed; i. e.* it consists of a bed of coal with its regular bed of fire-clay, upon which a second bed of fire-clay rests, which supports another bed of coal; and this upper bed, moreover, is commonly divided into two benches by a slate parting. Openings made upon this bed are frequently driven in upon the upper bed, the operator being ignorant of the existence of *another bed of coal beneath the fire-clay.* We therefore find many measurements of this bed that show a single bed of coal resembling, in many respects, the structure of other beds. But it sometimes happens that the lower coal is actually absent, and the bed exists as a single bed with no distinguishing peculiarity. A generalized section of the bed may be of service. Thus:

Slate, sandstone, or fire-clay roof	
Coal.	
Slate, bone, or Slaty Coal, ...	0″ to 1′ 0.″
Coal.	
Fire-clay (occasionally Slate,)	1″ to 4′ 0.′
Coal.	
Fire-clay.	

The middle bench of coal is commonly thicker than either the top or bottom bench. The bottom bench is often extremely sulphurous. The top bench is sometimes only a few inches thick, and sometimes is either wanting or, owing to the absence of the parting slate, has united with the middle bench.

At some openings the coal shows apparently as a bright, clean coal, with no sulphur visible, but an analysis nearly always discloses the presence of over two per cent of sulphur, and the coal rarely yields less than nine or ten per cent of ash, while it frequently runs up to twelve per cent.

When the bed is dirty and slaty, both the sulphur and ash will exceed these percentages.

The structure of this bed, as given above, is typical over a large area. Dowler's new opening at Burnside, and Brady's old opening near by, both show this structure. Mr. Harvey has lately found the bed in this condition in the northern part of Girard (?) township, near the county line. This is also its character in Morris township, and also at Osceola, while openings on Chest creek, in Cambria county, have disclosed the same structure.

Clarion Coal—Bed A'.

This is frequently absent, its place being occupied by the Clarion sandstone, which sometimes occupies almost the entire interval from Bed B down to Bed A. It is never a workable bed in Clearfield county, and may therefore be briefly described. In thickness it ranges from a few inches up to a maximum of a little more than two feet. It is frequently slaty and often sulphurous, but occasionally yields very good coal.

Brookville Coal—Bed A.

In Clearfield county this is one of the most unreliable beds of the series. It ranges all the way from a few inches up to four feet or more in thickness, and is at times entirely absent. When of good thickness its slaty or sulphurous character will generally prove an effectual bar to successful mining. At a few localities very fair coal has been obtained from this bed, but at these localities the bed was quite thin. This seems to be one of the peculiarities of the bed in this district, that when thin it yields coal of good quality, but when of good thickness its coal is commonly either slaty or sulphurous.

Immediately beneath this bed, and resting immediately upon or a short distance above the Conglomerate, occurs the fire-clay that has been so extensively used in the manufacture of fire-brick along the line of the Tyrone and Clearfield railroad.

Intra-conglomerate Coals.

At a few places along the Susquehanna, between Clearfield and Keating, coals of workable thickness have been found in the conglomerate measures, but I did not find any banks on these beds that had not fallen shut. I am convinced that these coals are not persistent, that they are uncertain and unreliable in thickness and that they rarely reach or exceed a thickness of three feet.

Limestones in the Coal Measures.

Three beds of limestone are certainly present in Clearfield county, but they cannot be considered as absolutely persistent, for in some districts one or two are undoubtedly absent.

Freeport Upper Limestone. This is found from six to twelve feet below the Freeport Upper coal, but is frequently absent. In fact this stratum may be considered as very rarely present. Its horizon, however, is frequently marked by iron ore which exists in its associated shales even when the limestone is itself absent.

Freeport Lower Limestone. This is thicker than either the Freeport Upper Limestone or the Johnstown Cement bed, but is often entirely absent. It occurs from one to four feet below the Freeport Lower coal—Bed D. It has been quarried and burnt at many localities in the county, and generally makes a better lime than either of the other beds. It ordinarily is from two to four feet thick, but occasionally attains a local size of six or eight feet.

Johnstown Cement Bed. This cement-limestone occurs from one to four feet below the Kittanning Upper coal, and is generally from eighteen inches to two feet and a half thick. It is more easily found and probably more frequently present than either of the Freeport Limestones, and therefore constitutes a more valuable key-rock.

The Ferriferous Limestone I have not recognized in Clearfield county; but, from the fact that limestone is often reported found some distance below Bed B, I have little doubt that this rock is present in some localities.

If the lime rock exposed in the railroad cuts near Tyler's, on the Low Grade railroad, is the Ferriferous Limestone, then the question of the eastern extension of this stratum is settled, for the rock there seen becomes a sand-rock in a distance of a few hundred feet, and in another cutting the same rock changes by almost imperceptible gradations into a very hard, dark, steel-colored mud-rock, which contains much very fine sand.

Mr. d'Invilliers has found an impure limestone in the measures underlying Bed B, in the Snow Shoe district. It is doubtless the representative of the Ferriferous Limestone.

Iron Ores.

Beds of carbonate of iron are found at several horizons in the coal measures, and also in the Conglomerate measures, and associated with the red shales of No. XI. Shales containing more or less ball ("kidney") ore occur between the Freeport coals and in the Conglomerate measures; but there are probably few, if any, localities in which these ore balls occur in sufficient quantity or the carbonate ore bands are of sufficient thickness for remunerative mining.

As these deposits are at present almost entirely undeveloped, except by old workings long since fallen shut, it was impossible to obtain any reliable information as to the thickness of the ore bands or ore-bearing shales.

Many years must elapse before any of these deposits can be profitably worked, and a large amount of prospecting will be necessary to discover, develop, and define those areas in which ore exists in sufficient quantity to warrant the erection of a mining plant.

Chapter V.

The Houtzdale–Philipsburg Basin.

This is the First basin of the First Geological Survey. Its central line has already been described as extending north-east from Philipsburg, and rising so that the central depression appears to be "spooning out" to the north-east. But while this central line of depression apparently disappears near Morrisdale, the basin is still a well-marked trough east of Kylertown in Morris township, and it would not be surprising to find on minute examination that the central line of depression running north by east from Pardee colliery is deflected eastward near Morrisdale, and is continuous with the synclinal that crosses Moravian run on the Clearfield Bituminous Coal Company's land. However, my impression is that while the basin is undoubtedly one and the same with the Philipsburg basin, the *central line of depression* of the latter is not continuous with that of the former.

The Morris township synclinal is doubtless continuous on the north-east with the Snow Shoe trough, but this will be discussed by Mr. D'Invilliers in his report on Centre county.

At Philipsburg and Houtzdale there is no difficulty in defining the position of the basin. Its axis or central line is found almost exactly coincident with the course of Beaver run at Houtzdale. From this point it runs about No. 60° E., passing between the Old and New Moshannon banks; and, passing between the Old Langdon bank and Mapleton bank, it runs on to the town of Phillipsburg. At this point it is deflected sharply away from the mountain, by what appears to be an anticlinal axis dying down from the north-east, so that its course is about N. E., or possibly N. by E., passing through the Empire and Pardee workings on

the Pardee Branch R. R., and about one mile east of Morrisdale.

The synclinal axis seems to be nearly level (barring faults) from Houtzdale where, the coal (Bed D) lies at an elevation of about 1530 feet above tide, to the Old Moshannon workings. The coal is here thrown up by a series of faults, so that near the mouth of Coal Run the elevation of the central line of the axis is about 1580–1590. From the hills back of Osceola to the Hale openings the axis is sinking, and this sinking seems to continue to near Phillipsburg (Derby Branch,) where the coal lies at 1435. The axis then continues nearly level to the Pardee workings on the Pardee Branch, where it seems to be rapidly rising to the north-east.

The map of this basin, showing the outcrop of the Freeport Lower coal (Bed D) will make these facts apparent.

The Centre county side of the basin apparently catches only a small area of the upper beds, the rise on the south-east side of the axis being very steep.

Faults. The basin is full of faults.

Three of these at the Moshannon workings are shown on the map. Serious faults have also been encountered in the Morrisdale mines—an upthrow of 42 feet—in the Allport, Franklin, Penn, Arctic, and many other collieries; in fact, there are very few mines in this basin in which more or less serious disturbances have not been found.

Faults of the magnitude of those found in this basin—*e. g.*, the Moshannon 90 foot upthrow—are entirely unknown in the western counties, and here greatly add to the difficulty of identifying and naming the coal beds, and of determining the geological structure of the district.

The basin contains all of the Lower Productive Coal Measures, from the Mahoning sandstone capping the hill tops down to the Conglomerate, No. XII, and at the southern end of the basin the Mahoning sandstone is overlaid by 150 to 200 feet of Barren measures.

The Conglomerate, No. XII, does not come above water level along the central line of the basin on the Moshannon. At Osceola it probably lies only a short distance beneath the bed of the stream.

Going up the Tyrone and Clearfield railroad from Philipsburg we find the measures rapidly rising, and at Blue Ball station, four miles from town, we find the top of the upper member of the Conglomerate, No. XII, about thirty to forty-five feet above the railroad, or 1580 to 1585 feet above tide water.

This rock here shows about thirty or forty feet of white and yellowish sandstone with thin Conglomerate streaks, underlaid by a band of shaly measures beneath which the shaly false-bedded sandstones of the middle (or lower?) member of the Conglomerate are exposed.

Going up the railroad to Wallaceton, the rock rises nearly as fast as the railroad, so that a short distance below Wallaceton its top is nearly level with the railroad at an elevation of 1665 to 1670 feet.

A small anticlinal roll apparently passes through Amesville, in Woodward township, and runs in a nearly straight line approximately parallel to the course of the basin.

At Amesville, the Mahoning sandstone lies on top of this roll, but as the main axis rises very rapidly toward Wallaceton, this roll also rises, and after passing the head of Coal Run the top of the Conglomerate is elevated on the crest of the axis to nearly 2000 feet above tide where seen near the Fireclay mines. From this point the First Axis must be rapidly declining to the north-east, as the elevation of this rock at Wallaceton is not much over 1725 feet.

The Houtzdale Basin in Gulich and Beccaria Townships.

Passing south-west from Houtzdale, along the central line of the basin, we find the coal (Freeport Lower, Bed D,) passing beneath water-level near the West Moshannon Bank, two miles from Houtzdale. The basin continues on south-west, passing near Ramey, and crossing the main or west branch of Muddy Run about one mile west of Janesville; it passes close to Utahville, and thence into Cambria county.

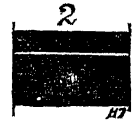
The central line of the basin is sinking rapidly from Houtzdale south-west; for, where it crosses Muddy creek,

nearly all of the Lower Productive measures are beneath water-level, and at Utahville the basin holds nearly 300 feet of Barren measures.

Over the central part of Gulich township the measures are dipping very strongly to the west or north-west. The Lower Productive coal measures occupy the surface in the eastern part of the township.

Going south-east from Ramey we find indications of much prospecting, but the holes are generally fallen shut or have been purposely closed, so that nothing can be learned of the value of the coals. I am informed that on the R. B. McCully place the Freeport Upper coal was opened 4′ 2″ thick; that the next bed (Freeport Lower, D,) was found 3′ 10″ thick, and that a second opening on the next bed below (the same bed, as I take it,) gave:

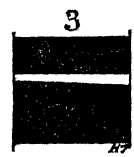
Coal, ... 12″
Slate, ... 1½″
Coal, ... 2′ 8½″



Limestone has been found in the fields below the smut of the Freeport Upper coal. Going south to the Davis bank, which lies about one and a half miles south-east from Janesville, we find the Mahoning sandstone capping the hills. It shows a strong north-west dip.

The coal opened at the Davis bank lies not more than sixty or seventy feet below the Mahoning sandstone, and is, therefore, the Freeport Lower coal—Bed D—but it has commonly been considered to represent Bed B, because it shows a slate parting like that bed. I feel tolerably confident that this is the Freeport Lower coal. It shows (reported):

Block slate roof.
Coal, ... 1′ 10″
Slate, with bony coal, ... 3″ to 7″
Coal, ... 3′ 6″
Fire-clay floor.



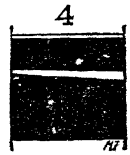
The analyses of this coal given in report H, made by Mr. McCreath, is as follows:

Water, ...	0.640
Volatile matter, ...	23.010

Fixed carbon,	71.789
Sulphur,	551
Ash,	4.000
	100.000
Coke, per cent,	76.35

The same coal is opened on the opposite side of the run on the W. T. McDonald place, where the bed measures:

Hard slate roof.
Bony coal, ... 2″ to 4″
Coal, ... 1′ 6″
Bony coal and slate, ... 3″ to 8″
Coal, ... 3′ 0″ to 3′ 4″
Fire-clay floor.



The central parting generally consists of one or two inches of sulphurous slate that turns white on weathering, and two to four inches of bony coal, some of which lies above and some beneath the slate band.

The Freeport Upper coal is here reported about three feet thick in the next bench, lying thirty or forty feet above Bed D. The Kittanning Upper coal has been dug into 55 feet below the Davis bank.

Going north-west towards Janesville these coals quickly pass down below water level, so that at the dam near Janesville the Mahoning sandstone is near water level. A small coal not quite three feet thick is here opened by Flynn's bank a few feet above water level. The same bed is opened at Robeson's bank, on Muddy run, one mile and a half north-west from Janesville, but the coal there lies about 120 feet lower than at the Janesville dam. The Mahoning sandstone is also just above stream level at this opening. The coal on which these banks are opened is probably the Gallitzen bed, lying immediately above the Mahoning sandstone.

Passing down the Janesville branch of Muddy run from Janesville, the Mahoning sandstone is seen in great blocks covering the ground.

Passing down Muddy run from Robeson's bank, we find the coal rocks gradually rising above water level, so that at the junction of Little Muddy run with the main stream, near the M. E. church and school-house, the Johnstown

cement bed is seen in the road about 55 feet above water level. The Freeport Lower coal, Bed D, should, therefore, lie about 90 to 110 feet above water level at this point.

In the next half mile the rocks rise very rapidly, and we see the Kittanning Lower coal—Bed B—opened at an old bank about forty feet above water level in Muddy run. Passing down towards Madera we find another bank on this bed, but the coal is about fifteen or twenty feet *lower* than at the former opening. This shows the presence of the minor roll, which passes through Amesville and through the coal opened near the head of Coal run, Mapleton, and Crowell run and Derby branches, etc., etc.

At Madera this rise to the east and north-east is also apparent, for the coal, (Bed B,) where opened on Alexander run above Hensel's hotel, is fully sixty feet above the creek. This west dip does not long continue, for as we pass down Clearfield creek we find the Conglomerate coming up above water level, so that where it plainly shows two miles below Madera it lies 180 to 220 feet above the stream.

Clarion Sandstone at Madera.

At Madera the Clarion sandstone plainly shows its presence beneath Bed B by the masses of coarse sandstone near Hensel's Hotel. This rock is also seen in a similar position near the railroad, a short distance west from Osceola.

General Section.

Houtzdale-Morrisdale Basin.

Mahoning Sandstone,	0′ to 60′
Soft Slates and Shales, ferruginous,	35′ to 40′
Freeport Upper Coal—Bed E,	2′ to 3′
Fire-clay,	25′ to 35′
Freeport Upper Limestone (seldom seen),	
Shales, (sometimes sandy,)	
Blue Slate,	
Freeport Lower Coal—Bed D,	4′ to 6′
Fire-clay,	2′ to 4′
Freeport Lower Limestone,	0′ to 2′
Freeport Sandstone, (sometimes replaced by Blue Fissile Slate),	35′ to 45′
Kittanning Upper Coal—Bed C,	2′ to 3′
Fire-clay, etc.,	3′ to 5′
Johnstown Cement Bed (Limestone),	0′ to 2′
Slates and Shales, (with a small coal),	25′ to 30′

Kittanning Middle Coal—Bed C,	1′ to 3′
Fire-clay,	
Shales and Slates,	30′ to 40′
Kittanning Sandstone,	
Slate,	
Kittanning Lower Coal—Bed B,	3′ to 6′
Interval to water-level of Moshannon Creek below Osceola,	

Mahoning Sandstone.

This is a pebbly sandstone or conglomerate along the Amesville ridge as far north-east as the head of Coal Run; but coming east towards the center of the basin it loses its pebbly character, and commonly occurs as a fine or rather coarse-grained whitish sandstone. It is sometimes shaly or friable; and in many localities is either replaced by soft sandy shales or is entirely absent, its place being occupied by the Barren measure shales and slates.

Freeport Upper Coal, E.

This bed has been opened at many places at from 25 to 35 feet above the top of Bed D. It has been worked at only a few banks. At the Derby bank, on the Derby branch, and at Hale's old abandoned bank near the mouth of Laurel Run, (Mapleton Branch R. R.,) this bed has been worked in the past but is now abandoned.

It is supposed that the Atalanta bank, now being opened by Welch, Epley & Co., on the new Mapleton Branch R. R., is located on this bed. The bank shows about three feet, or possibly a little more of good, bright coal without any persistent parting.

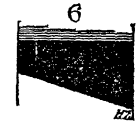
This bed commonly contains not more than about 2′ 6″ of coal, but in places fully three feet of coal will be found at this horizon.

On the Derby branch it shows a trifle more than three feet of coal, thus:

Slate roof.	
Coal,	2′ 8″
Slate, (not persistent,)	1″ to 2″
Coal,	6″
Fire-clay floor.	

In the Houtzdale district it is rarely more than two feet thick.

At the Hale (Upper) opening the bed is now variously reported as from 18 inches to three feet thick, thus:



Soft slate roof.
Coal, ... 1′ 6″ to 3′ 4″
Fire-clay floor.

An analysis, made from a sample selected by the Survey, is given by Mr. Platt, as follows: (McCreath.)

Water,	0.570
Volatile matter,	24.630
Fixed carbon,	68.400
Sulphur,	1.900
Ash,	4.500
	100.000

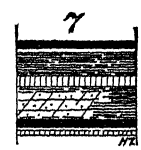
Coke, per cent, 74.800; color of ash, grey, with red tinge. "The coal is bright, shining, columnar; contains small veins of iron pyrites."

I think this analysis hardly represents the average character of coal from the bed throughout the basin. The coal is commonly clean and bright, and with only a small percentage of sulphur.

Workings will doubtless be opened on this bed in the future, but it cannot be considered as a very valuable deposit in this part of the basin, because, 1. It is not thick, 2. It lies too close to the hilltops to afford a very large workable area, and 3. It has been ruined over large areas by workings on the underlying bed.

Freeport Upper Limestone.

This is not noted in the general section. I have not been able to find it. The *upper* limestone given in the following section, taken from the report of the First Survey, probably represents this bed.



Coal (Bed E?),	4′
Fire-clay,	2′
Calcareous Slate,	8′
Blue Compact Shale or Indurated Clay,	1′ 2″
Ferruginous Shale,	2′
Limestone, blue, ferruginous, (U. F. L.?),	5′
Sandstone and Shale,	19′

Coal, good, (Bed D?),	4' 4"
Fire-clay,	2'
Limestone, ferruginous, passing into Iron Ore, (L. F. L.?),	2'
Sandstone, (interval too small?),	16'
Coal in Creek Bed, (K. U. C.?),	1' 18"

Freeport Lower Coal—Bed D.

This is the bed worked by nearly all the collieries now shipping coal from this district. It commonly yields from four to five feet of coal, but varies locally from three to seven feet in thickness. In the north-eastern part of the basin it usually contains a parting of slate one or two inches thick, from six to fifteen inches above the floor of the coal.

On Goss Run a parting sometimes occurs five to eight inches from the roof. In the vicinity of Houtzdale, and north-east towards the Mapleton Branch, the bed is all clean coal, without any slate parting, but a layer of bony coal four to eight inches thick is often found resting immediately on top of the bed.

The following analyses (from Report H) made by Mr. A. S. McCreath, from samples furnished by Mr. Platt, will show the excellent character of coal from this bed:

Analyses of Coal from Bed D.

No.	Water.	Volatile Matter.	Fixed Carbon.	Sulphur.	Ash.	Color of Ash.	Coke, Per cent.
1, .	.81	20.640	74.023	.507	4.02	White,	78.550
2, .	.67	21.360	74.284	.435	3.251	Cream,	77.97
3, .	.78	21.690	73.052	.688	3.80	Gray,	77.540
4, .	.71	23.400	72.218	.532	3.14	Gray, with red tinge,	75.890
5, .	.76	20.090	74.779	.666	3.70	Gray, with red tinge,	79.145
6, .	1.10	23.070	71.199	.611	4.02	Red,	75.830
7, *.	1.10	22.450	72.300		4.15		
8, .	.74	23 210	68.628	2 122	3.30	Red,	74.050
9, .	.70	23.585	68.89	1.715	5.13	Gray,	75.735
10, .	.62	22.135	68.728	.867	7.65	Gray,	77.245
11, .	.80	23.260	72.35	.590	3 00	Red,	75 940
12, .	.55	24.09	71.689	.571	3 10	Gray,	75.36
13, .	.56	25.19	71.013	.587	2.65	Salmon,	74.25
14, .	.41	22.81	66.69	.179	8.30	Gray, with red tinge,	76.78

*Analysed by Booth and Garrett.

The excellent character of this coal, especially for metallurgical use, is shown by the following tables taken from the same source:

Analyses of Ash of Coal from Bed D.

No.	Silica.	Oxide of Iron.	Alumina.	Lime.	Magnesia.	Phosphoric Acid.	Sulphur.	Per cent of Ash in Coal.
1,	2.040	.350	1.140	.136	.032	.007	. . . . .	4.020
2,	1 660	.560	1.360	.134	.046	.013	. . . . .	3.800
3,	1.675	1.570	1.480	.221	.154	.013	. . . . .	5.130
4,	3.493	.750	2.700	.302	.168	.237	. . . . .	7.650
5,	2 100	3 550	1.550	.090	.206	Trace.	. . . .	7.540
6,	1,450	.350	.500	.260	.198	.047	.054	3.100

Analyses of Coal D for Phosphoric Acid.

Name of Colliery.	Per cent in Coal.	Per cent in Ash.
Penn Colliery, Houtzdale,	.007	.174
Franklin Colliery, Houtzdale,	.005	.047
Eureka Mine, Houtzdale,	.013	.342
Sterling Mine, Houtzdale,	.005	.159
Moshannon Colliery,	.006	.162
New Moshannon Mine,	.005	.124
Mapleton Colliery,	.013	.253
Logan Colliery,	.237	3.098
Laurel Run Colliery,	.011	.366
Decatur Coal Co.'s Colliery,	Trace.	
Morrisdale Mine, Lower Bench,	.047	1.516
Morrisdale Mine, Upper Bench,	.022	.330
Derby Colliery,	.033	.397

Iron and Sulphur in Coal D.

Name and Location of Colliery.	Per cent of Sulphur.	Per cent of Iron.	Sulphur reqired by Iron to form Iron Pyrites.	Sulphur left in Coke	Per cent of Sulphur in Coke.
Decatur Coal Co.'s Colliery,	1.473	.595	.680	.842	1.118
Penn Colliery, Houtzdale,	.507	.245	.280	.264	.336
Franklin Colliery, Houtzdale,	.875	.581	.664	.328	.414
Eureka Mine, Houtzdale,	.688	.392	.448	.451	.581
Mapleton Colliery,	1.715	1.099	1.256	.568	.750
Logan Colliery,	.867	.525	.600	.628	.813
Decatur Coal Co.'s Colliery,	3.378	2.485	2.840		
Morrisdale Mine, near Phillipsburg,	.571	.245	.280	.302	.400

List of Collieries working Bed D.

Allport Bank, head of Pardee Branch R. R., ... Holt, Schoonover & Co.
Pardee Bank, on Pardee Branch R. R., ... Duncan, Lingle & Co.
Empire Bank, on Pardee Branch R. R., ... Empire Coal Co.
Morrisdale Mines, head of Morrisdale R. R., ... R. B. Wigton & Sons.
Decatur (New) Bank, on Morrisdale R. R., ... Decatur Coal Co.
Decatur (Old) Banks, " " " . . . . (Abandoned.)

Derby Bank, on Derby Branch R. R., . Barnes Bros.
Spring Hill Bank, " " " " . A. B. Lueder.
Cuba, or Leonard Bank, " " " " . John Ashcroft.
Cody Ridge Bank, " " " " . H. K. Grant.
Colorado Bank, " " " " . A. & W. H. Barlow.
Lancashire No. 1 Bank, " " " " . Campbell, Tucker & Co.
Glenwood Bank, " " " " . George F. Huff & Co.
Victor No. 1 Bank, " " " " . Victor Coal Co.
Hudson Bank, on Tyrone and Clearfield R. R., . . . D. D. Dodge & Co.
Keystone Bank, on Mapleton Branch No. 2 R. R., J. A. Losie.
Victor Nos. 2 and 3 Banks, " " " " Victor Coal Co.
Lancashire No. 2 Bank, " " " " Barnes Bros.
Laurel Run No. 2 Bank, " " " " Josiah M. Bacon.
Logan Ridge Bank, " " " "
Coaldale Bank, " " " " R. H. Chipman & Co.
Reading Bank, on Mapleton Branch No. 1 R. R., . Henry Liveright.
Logan Bank, " " " " . H. Liveright & Co.
Laurel Run No. 1 Bank, " " " " . Josiah M. Bacon.
Columbia Bank, " " " " . Mitchell & Keller.
Mapleton Bank, " " " " . Berwind, White & Co.
Hale's Bank, " " " " . (Abandoned.)
Langdon's Bank, on Tyrone and Clearfield R. R., . (Abandoned.)
Country Banks, in hilltop at Osceola, ... Several owners.
Reed's (Coaldale) Bank, at Coal Run Junction, . . R. H. Chipman & Co.
Arctic Bank, on Coal Run Branch R. R., . Hoyt, Losie & Co.
Ashland Bank, at head of " " " .
Newcastle Bank, head of Little Beaver Run, ... Harned, Jacobs & Co.
Eureka No. 3, on Houtzdale Branch R. R., . . Berwind, White & Co.
Old Moshannon, " " " " . . (Abandoned.)
New Moshannon, " " " " . . Moshannon Coal Co.
Beaverton Bank, " " " " . . John Maurice & Co.
Sterling No. 1, " " " " . . R. H. Powel & Co.
Eureka No. 1, " " " " . . Berwind, White & Co.
Lang and Co. Bank, " " " " . .
Sterling No. 2, on Goss Run Branch, ... R. H. Powel & Co.
Goss Run Bank, " " " . . . . . Berwind, White & Co.
Webster Nos. 1 and 2, " " . . . . . J. C. Scott & Sons.
Ocean Banks, " " . . . . . Harned, Jacobs & Co.
Excelsior Bank, " " . . . . . Fisher Bros. & Miller.
Eureka No. 2, on Goss Run Branch No. 2, . Berwind, White & Co.
Pacific Nos. 1 and 2, " " " " 3, Harned, Jacobs & Co.
Penn Bank, on Houtzdale Branch R. R., . Rickert Bros. & Co.
Franklin Banks, " " " " . . Kittanning Coal Co.
Houtzdale Coal Co., " " " " . Houtzdale Coal Co.
Beaver Run, " " " " . . Beaver Run Coal Co.
West Moshannon, " " " " . . Moshannon Coal Co.
Atlantic Bank, " " " " . . Harned, Jacobs & Co.
Kendrick Shaft, " " " " . . " "
Eureka Nos. 4 and 5 (?) on Moshannon Extention R. R. Berwind, White & Co.

I think the above list embraces all of the banks working

this bed at present. It is possible, however, that one or two may have been accidentally omitted.

Freeport Lower Limestone.

Beneath the clay underlying the Freeport Lower Coal—Bed D—the Freeport Lower Limestone is occasionally found. It is reported as being from one to two feet thick, and is sometimes replaced by ore balls (carbonate of iron). It lies two or three feet beneath the coal.

At the old Decatur bank, on the Morrisdale Branch Railroad, some of the stone was taken out and burnt. It was here found from eighteen inches to two feet below the coal (Bed D). It has also been found beneath the coal at the Morrisdale mines.

Freeport Sandstone.

Throughout the Houtzdale-Morrisdale basin this rock is a thin-bedded shaly sandstone, rarely affording good outcrops. It is frequently entirely replaced by shale, and sometimes by a blue fissile slate. It is of little or no value as a key-rock.

Kittanning Upper Coal—Bed C′.

This bed is commonly found from forty to fifty feet below the Freeport Lower Coal (D), and is in this basin generally an utterly worthless bed. Where passed through at Morrisdale shaft it was 2′ 10″ thick, with a thick parting of slate in the middle of the bed. On the Kephart place, two miles north-west from Osceola, it is about thirty-five feet (making allowance for dip, over forty feet) below the Freeport Lower Coal, and contains twenty-six inches (2′ 2″) of coal, with a very hard clay-slate parting in the center about two inches thick. It shows the same structure near Amesville, but the parting is somewhat thicker than at Kephart's place.

Johnstown Cement Bed.

This is seen in loose fragments coming in under the smut of the Kittanning Upper Coal (C′), along the rail-

road, between the Victor No. 3 and the Laurel Run No. 2 banks. The Morrisdale shaft passed through two feet and five inches of limestone at this horizon.

Kittanning Middle Coal—Bed C.

This is an almost entirely worthless bed throughout this basin. It lies thirty to thirty-five feet below the Kittanning Upper Coal—Bed C'—and from thirty to forty feet above the Kittanning Lower Coal—Bed B.

However, while it is generally worthless, we sometimes hear of three feet or more of good coal being found at this horizon. On the Wilkinson place, near Osceola, it is reported as 2′ 6″ thick, with no slate partings. It is reported elsewhere as parted into two benches by from six inches to three feet of sandstone, and this is doubtless what troubles the bed where passed through by the Morrisdale shaft. In other localities it is reported as a mass of broken, slaty ("dirty") coal utterly unfit for use.

Some workable areas will doubtless be developed in the future; but the bed, as a whole, must be considered almost valueless.

Kittanning Sandstone.

This rock is generally a fine-grained gray, bluish or iron-stained sandstone, lying a few feet above the Kittanning Lower Coal—Bed B. It is of some use as a key-rock.

Kittanning Lower Coal—Bed B.

This bed is opened near water-level in Moshannon Creek, at Mr. Wilkinson's country bank, nearly opposite the Houtzdale Railroad junction below Osceola. It here contains a six-inch slate parting about one foot below the top of the coal.

At Philipsburg the parting is about the same thickness, but comes in two feet to two and a half feet from the top of the bed, with two and a half to three feet of coal beneath it.

The same structure appears at the Hawk Run bank on the Pardee Branch railroad.

The parting is generally described as fire-clay; it is a fire-clay slate or shale in some localities. The smut of this bed is seen on the Coal Run Branch Railroad, near the Junction, and 122 feet below Bed D. At Morrisdale this interval is 120 feet (floor to floor), and at the Wilkinson opening the bed lies 125 feet below the Langdon bank on Bed D.

This bed does not furnish coal that compares well with coal from Bed D. and it is not, therefore, of much value at present. According to common report the upper bench yields the best coal; (sometimes the lower bench is said to be most valuable;) and, if only one bench is mined, a superior fuel may often be obtained from this bed. The bed will doubtless be largely worked in the future; but at present competition is too great to enable operators to profitably mine it except at a few localities where it is favorably situated and of unusual excellence.

Freeport Lower Coal—Bed D in the Houtzdale-Morrisdale Basin.

The bed worked in the Houtzdale district is overlaid at a height of about thirty or thirty-five feet by another bed of coal. The bed worked in the Morrisdale and Derby Branch district is also overlaid at about this distance by a similar bed of coal. About thirty-five or forty feet above this upper bed we find the Mahoning Sandstone lying in the hills near Amesville, and also capping the hills on the Mapleton Branch No. 2, near the Victor No. 2 opening. Thus, in these two districts, we have:

Houtzdale District.		*Mapleton, Derby, Morrisdale District.*	
Massive conglomerate sandstone in Hilltops.		Massive sandstone in Hilltops.	
Interval of	35′ to 40′	Interval of	35′ to 40′
Coal, about	2′	Coal, ...	2′ 6″ to 3′ 4′
Interval of	30′	Interval of	30′ to 40′
Coal worked at Houtzdale,	5′	Coal worked at Morrisdale,	5′

This comparison would seem to constitute a sufficient proof of the fact that the Houtzdale and Morrisdale workings are on one and the same bed, but we have other cogent reasons why this is the only tenable view:

1. If the Houtzdale workings are considered to be opened on Bed B, then we should find beds C, C', D, and E in the hills between Houtzdale and Ramey, and we do *not* find these coals in these or any other hills above the Houtzdale bed. Only one bed of coal is found above the Houtzdale bed, except a small streak of coal six inches, or possibly one foot thick, lying immediately beneath the Mahoning Sandstone.

2. If this bed is Bed B, then the conglomeratic rock at Amesville should be the Pottsville Conglomerate, No. XII, and should lie *beneath* the coal; but it is found only a short distance *above* the coal, and is undoubtedly the Mahoning Sandstone.

3. The coal can be traced almost continuously, from bank to bank, from the Houtzdale district to Morrisdale; and this I will now proceed to do, giving, at the same time, what miscellaneous notes I have made at the different openings.

To trace out the continuity of this Freeport Lower coal throughout the principal banks worked in this basin, I shall commence at the old Moshannon mines and first trace the bed south-west to its point of submergence below water level above Houtzdale; then returning to the Moshannon workings, I shall indicate its extension north-east through the Eureka No. 3, the Arctic, and Reed's bank workings.

Beginning at the old Moshannon workings, we find a series of *faults* that would constitute an effectual bar to successfully tracing the coal south-west were it not for the fact that this area has been so extensively worked that the faults are well defined by actual developments.

The first and oldest Moshannon opening is on the east side of Beaver run, at an elevation of about 1536 feet above tide. The outcrop here rises rapidly south by west until an elevation of about 1611 feet is attained, when a fault throws it abruptly down 40 feet to an elevation of about 1571 feet at the old Beaverton bank.

At the Moshannon bank now working, almost directly opposite the first opening, the coal lies about 1595 feet above

tide. The outcrop rises rapidly to the south-west for a short distance, when it is abruptly thrown down by a fault (about 90 feet) to an elevation of about 1520 feet. This fault has been found on the opposite side of the run, between the First Moshannon bank and the Eureka No. 3 opening.

Passing south-west to the Sterling No. 1 bank, we find the coal at an elevation of about 1510 to 1515 feet above tide.

At Morris Lang & Co.'s bank, near Houtzdale, the coal lies about 1530.

Going up the Goss Run Branch, we find the coal opened at the Sterling No. 2 banks at about 1568.

The Goss Run (Mear's) bank is about 1585.

At the Webster Nos. 1 and 2 banks, the coal lies at about 1600 to 1605. The bed here shows:

Slate roof.	
Coal, ...	6″ to 10″
Slate, ...	1″ to 2″
Coal, ...	4′ 3″ to 5′ 0″
Fire-clay floor.	

but is six feet thick in some parts of the mine.

At the Ocean banks the coal is 1615 to 1645 feet above tide. It is here worked through the hill north by east into the valley of Little Beaver Run. A trestle crosses this run to the New Castle bank, which is opened at an elevation of about 1770.

Passing up the south branch of Goss Run, we find the coal (Bed D) opened at the Pacific Nos. 1 and 2 banks at about 1640 feet above tide, and at the Eureka No. 2 opening at 1658.

At the Eureka No. 1 and Penn banks, opened on the west side of the run at Houtzdale, the coal lies from 1530 to 1540 feet above tide. At the Eureka bank the coal was found comparatively undisturbed by serious faults; but in the Penn (and Franklin, also,) bank the coal was very badly faulted in many parts of the workings.

Throughout this area the coal commonly shows from 3′ 6″ to 5′ of clean, shining coal.

Passing up Beaver Run above Houtzdale, we find the

bed sinking down to water-level at the West Moshannon and Beaver Run banks. The Atlantic bank starts some thirty feet above the level of the coal, and the Beaver Run bank is also above it, while the Houtzdale company's new bank is opened by a slope, and at the Kendrick shaft the coal lies sixty-seven feet below the surface.

Returning to the Moshannon openings, and passing down Beaver Run, we find the coal next opened at the Eureka No. 3 bank at an elevation of about 1583.

The identity of the coal here worked with that at the Arctic opening at 1574, and at Reed's bank at 1585, can hardly be questioned; but every one may not be satisfied with this identification. However, we have, fortunately, a check on this in the tracing of the coal from the Arctic opening up Coal Run, and across to the Newcastle opening on Little Beaver Run.

At Reed's bank, where Bed D is worked on the crown of the hill lying on the east side of Coal Run near Coal Run Junction, the coal lies at an elevation of about 1585 to 1600 feet above tide, thus showing it to be slightly higher than at the Arctic opening, where the elevation is about 1574. This opening lies nearly east from the latter; they are about one mile apart. The coal worked at Reed's bank lies in the top of the hill with only a few feet of soft cover. The bank is nearly exhausted.

(A cutting on the Coal Run branch railroad a few hundred feet from the junction—just beyond the Reed bank tipple —shows the presence of a bed of coal of considerable thickness. This is doubtless the Kittanning Lower coal, Bed B. It may be considered to lie at an elevation of 1463 feet above tide, or 122 feet beneath the Reed bank opening on Bed D.)

At the Arctic bank, opened in May, 1883, by Holt, Lewis & Company, on the south side of Coal Run, one mile above Coal Run Junction, on the Houtzdale Branch R. R., the elevation of coal D is 1574.±

The bed is from four to over six feet thick. Two entries have been started a short distance apart, but only one is now being worked. This entry is driven in a short dis-

tance, and then branches into three roads. Along the right-hand road the coal has a local dip unfavorable to working. On the middle road a fault has been encountered, so that the workings are at present confined to the left-hand road, on which seven rooms eighteen feet wide were being worked at the time the mine was visited. The coal is bright and clean, containing much mineral charcoal. It is apparently very free from sulphur. What sulphur is visible occurs in small round balls or dots.

The bed has a blue slaty roof, sometimes shaly, a few inches to one or two feet thick, above which some slaty shale weathering olive may be seen on the railroad a short distance above the bank mouth.

The coal is also apparently overlaid by the mass of flaggy sandstones visible near the dump, but these may possibly come in beneath the bed. From the exposures seen about one mile above this bank, I am disposed to take the latter view.

Land-slip or Fault. The bed was worked here fifteen or sixteen years ago, but the old entry is seen at a much lower level than the present working. By barometer, I made the difference in elevation about forty feet, the distance between the two openings being about six or eight hundred feet in an air line.

The coal opened and worked from this lower opening covered only some twelve or fifteen acres, and was contained in a small nose or round-top partly separated from the main ridge between Coal Run and Little Beaver Run. The bed had only a few feet of cover, and the old workings are said to have been very irregular.

It is reported that some of the roads in these old workings had such a steep grade that it was necessary to sprag all four wheels to control the descent of the cars. As the coal north-west and south-east of this point apparently does not partake of this abrupt dip, I am inclined to consider the irregularity caused by a local fault or possibly by a land-slip.

Proceeding along the Coal Run railroad north-west from the Arctic bank, coal D smut is visible at several points in

the railroad cuts, and at one point not quite one mile from the Arctic opening the bed has been dug into and its full thickness exposed at an elevation of about sixty-five feet, more or less, above the Arctic bank, or say 1640 feet A. T.

This shows the beginning of the rapid rise towards the Ashland opening. From this point north-west to the pike-crossing, the smut of the bed may be occasionally detected in the cuts, but the bed itself evidently lies at some distance above the railroad track throughout this distance. The same conditions are noticeable from the pike crossing up to the Ashland Bank dump.

At the Ashland bank, which is a recently opened working, the coal lies at an elevation of 1,881 feet above tide, but the ground is high at this point and the coal has one hundred feet of cover.

The coal here seems to carry much more sulphur than at the last locality visited.

The Mahoning Sandstone is seen in force in the hill above the bank. It is here a massive sandstone containing some conglomeritic layers and some beds wholly composed of pebbles varying in size from that of a pea down to small bird shot, but a few pebbles as large as a hazelnut are visible in some parts of the rock.

Fragments from this rock come down and cover the hill-slopes in various directions, often reaching far down below the place of the coal.

The Mahoning Sandstone evidently exists in force in the hills on the north-east side of Coal Run; but, as we descend towards the mouth of Coal Run, it either loses its character as a massive sandstone or conglomerate and becomes very friable or shaly, or entirely thins away; for, in the vicinity of Reed's bank, I was unable to detect it.

On the north-west side of the stream opposite the Arctic bank, its presence is shown by large bowlders and blocks lying on the hillsides both above and below the bench marking the probable position of the coal (D).

Returning to Ashland and going south-west along the pike to Amesville, we see constant signs of the presence of this rock. Its character is not always uniform, but is suf-

ficiently so to enable us to trust in it as a good key-rock for this particular district.

From the Ashland opening over to the Newcastle bank, near the head of Little Beaver Run, a distance of about one mile—a little west of south—the *Mahoning sandstone* furnishes a sufficiently good key-rock, and we may be reasonably certain of the identity of the bed at these two places.

The Newcastle opening on Coal D is at an elevation of about 1770 A. T. From this point to Ashland the rise is, therefore, about 110 feet (in one mile) N. by E. From the exposure on the railroad above the Arctic bank (1640±) to Ashland bank the rise is, therefore, 241 feet, which is at the rate of about 160 feet per mile, N. W.

This coal D worked on the two Mapleton Branch railroads can be readily traced from point to point, so that there can be no doubt of the continuity of the bed throughout this area.

Starting at Laurel No. 1 opening we will go through the hill, trace the coal down Mapleton No. 2 branch railroad and up the old Mapleton branch railroad to the starting point, and thence down the Mapleton branch past the old Hole and Langdon openings to Reed's bank at Osceola.

As coal D has been holed completely through the hill, from Laurel Run No. 1 north-eastward, we may readily cross over to the head of the Mapleton Branch R. R. No. 2, at what is now known as the Laurel Run No. 2 bank. The coal here lies at an elevation of about 1620 A. T.

The coal D is here about five feet thick, and seems to be quite free from sulphur. This Mapleton No. 2 R. R. branch has just been built, and all the banks opened along it—the Laurel Run No. 2, Victor No. 3, Lancashire No. 2, Victor No. 2, Atalanta, Keystone, Logan Ridge, and Chipman & Co.—are new workings.

At the Victor No. 3 bank Coal D lies at about 1630 feet above tide water, and shows five feet of good bright coal. A thin slate or bony parting is reported as occurring about eight inches above the bottom of the bed, but I do not think it will be found persistent.

(The Freeport Upper coal bed (E) has been worked on the Hughes place. It lies about 35 feet above the coal opened by Victor No. 3 and Lancashire banks. Is reported as being over three feet thick.

In the railroad cut between these two openings, and about fifty feet below the coal, some bowlders of limestone have been exposed to view. This is doubtless the *Johnstown cement bed* of Cambria county, which occurs beneath the Upper Kittanning coal bed C'.)

At the Lancashire No. 2. bank, Mr. d'Invilliers gives 1583 feet above tide as the elevation of the coal (D).

Going down the run, we find it opened at an elevation (as given by Mr. d'Invilliers) of 1542 feet at the Victor No. 2 bank and 1511 at the Keystone bank.

(Large blocks of massive sandstone, almost entirely without pebbles, cover the hill in the vicinity of Victor No. 2 bank. It lies in place in the top of the hill about 70 to 75 feet above the coal. The loose blocks are now being broken up and used for bridge abutments, etc. It makes a very fair building stone. It is the *Mahoning Sandstone.*)

The Atalanta bank, opened by Welch, Epley & Co., is twenty-five or thirty feet higher than the Victor No. 2, and is supposed to be on the overlying bed. It shows about three feet to three feet three inches of fine bright coal. I am not at all certain that it is not opened upon the same bed with the Victor No. 2.

At the Keystone bank bed D is apparently much thinner than at the above described openings on this bed, but when the heading is driven further into the hill the bed may be found to thicken up—however, the bed seems to become thinner to the east and south-east as we also find it thinner at the Chipman, Reading, Hale, and Langdon openings than at the Mapleton, Laurel Run, and Victor, No. 3, etc., banks.

Coming down the opposite side of the Mapleton No. 2 Branch R. R. from the Laurel Run No. 2 opening, we find Bed D at the water drainage drift holed through from the Laurel Run No. 1 at an elevation of 1570±, and further

down at the Logan Ridge Bank of Mr. H. J. Smith, at an elevation of 1540 feet more or less above tide, and at the R. H. Chipman & Co. Bank, nearly opposite the Keystone opening, at an elevation of 1520 feet. The coal is here about three feet three inches thick.

Passing around the nose of the hill and going up the old Mapleton Branch R. R., we find Bed D opened at the Reading Bank at an elevation of about 1525 feet. The bed here shows from 3′ 4″ to somewhat over 4 feet of coal, and carries from 4 to 6 inches of bony coal on top the bed.

The next opening is at the Logan Bank where the coal is 1543 feet (Sanders) above tide.

The bed shows 3′ 6″ to 4 feet of coal with about six inches of bony on top the bed.

Going up the railroad we come again to the Laurel Run No. 1 bank at an elevation of about 1600 feet.

The bed D here shows:

Coal and bony,	6′ to 10″
Bony,	2″ to 4″
Coal,	4′ to 5′; averaging, 4′ 6″

Opposite this mine is the Columbia bank opened at nearly the same elevation. A serious fault has greatly interfered with operations at this point. A new drift is being driven at a considerable elevation above the first opening to strike the coal beyond the fault.

Passing up the Run we find much land high enough to contain Bed D with good cover. About one mile northwest, or west by north from the Laurel Run No. 1 opening, the bench formed by this bed of coal is almost constantly in sight; but, in this distance, the coal rises from fifty to sixty feet, so that it lies at elevations of 1630 to 1650 feet.

(The overlying Freeport Upper, Bed E, lies from twenty-five to thirty-five feet higher up. It has been dug into at a few points, and its presence is sometimes detected by smut on the roads.)

At Kephart's place, which is only a short distance west from the Columbia bank, Bed D four to four and a half feet thick has been opened by a drift near the main road,

and only a few feet from his house. It here lies about forty or fifty feet higher than at Laurel Run No. 1 bank. The terrace marking its outcrop shows a very strong south-east dip.

(Thirty-five feet below the bank Mr. Kephart has found a "twenty-six-inch bed." This bed contained about two inches of hard slate near the middle. Allowing for the strong dip here visible, I place this bed forty-five feet below the main bed, making it, therefore, Bed C', the Kittanning Upper Bed of the western counties.)

Bed D on the Goss or Drane farm, is at nearly the same elevation with Kephart's opening.

Returning to the Columbia or Laurel Run bank and passing down on the south side of the Run, we find Bed D next opened at the old Mapleton bank, worked by Berwind, White & Co., at an elevation of 1555 feet. In this bank the coal thins toward the east and thickens to the west, ranging as low as 2½ feet and as high as 4′ 6″, *averaging* about 3′ 6″

Proceeding down the run we find the coal opened at the old Hale Bank (now abandoned) at an elevation of about 1530 feet. The coal was very irregular in this working.

(Bed E was also opened at this place, 30 feet above Bed D, or at an elevation of 1585 feet, more or less. It is reported by Mr. Platt as showing 3′ 2″ to 3′ 6″ of coal. Both openings are now abandoned, and access is difficult if not impossible.)

Passing around the hill to the south we find two old abandoned openings on Bed D. These are known as Langdon's banks, and are at an elevation of between 1545 and 1555 feet.

(Bed B has been opened near water level by Mr. Wilkinson, a short distance south-west from Langdon's old opening and 120 feet below Bed D:

Slate roof of Bed B, *Kittanning Lower coal.*
Coal, ... 1′ 0″
Slate, ... 6″
Coal, ... 2′ 0′ 2′ to 6′
Fire-clay floor.

Mr. Wilkinson has prospected upon a coal

(Kittanning middle) lying forty feet above this bed and found about 2′ 6″ of coal. The Kittanning Lower coal (Bed B) is apparently the bed opened and worked at the Reliance or Enterprise bank, owned by Orris & Co., nearly opposite Mr. Wilkinson's opening; and also at the Clearfield Coal Co.'s bank opposite Osceola. These banks lie in Centre county.)

Passing west across the hollow from Langdon's opening to the hill above Osceola, a distance of about three quarters of a mile, we find Bed D opened at four or five small country banks, worked by Messrs. Estep, Shoff, Wilkinson, etc., at an elevation of 1585 to 1600 feet.

The coal here lies near the summit with little covering. It is 3′ 9″ to 4′ 6″ thick, without counting the coal and bony on top that is not worked. The bony band is 4 to 6 inches thick, and above this there are 6 to 8 inches of coal.

The coal is exposed on the main road leading north-west out of Osceola only a few hundred feet from these banks, but twelve or fifteen feet higher. Mr. Estep states that there is a fault in the hill throwing the coal abruptly up eighteen feet.

(Going north-west up the road, the smut of E is seen in the road about twenty-five feet above.)

From this point north-west the coal can be traced by its terrace and by old country banks without difficulty to the Kephart place, from which opening it has already been traced over to the Laurel Run No. 1, thus completing the circuit.

From the Victor Nos. 2 and 3 and the Lancashire No. 2 banks, on the Mapleton Branch R. R. No. 2, it is perfectly easy to cross over the hill north-east into the Derby Branch, and identify the two beds (D and E) we have been tracing from point to point.

At the Victor No. 1, where the hill is tunneled to the north-west, the Freeport Lower coal (D) is at an elevation of about 1540 feet, and the terrace of the Freeport Upper bed (E) is plainly seen about thirty feet higher up on the hill.

About fifty or sixty feet above this terrace the *Mahoning*

sandstone is seen along the road. The measures here show a strong dip to the south-east.

Passing down the run from the Victor No. 1 bank we see the Freeport Lower coal bed (D) opened at the Glenwood bank at an elevation of about 1493; at the Lancashire No. 1 bank at an elevation of about 1490; at the Colorado bank at an elevation of about 1460, and Cody Ridge bank, opposite, at 1450; at the Cuba or Leonard bank at 1435; at the Spring Hill bank at 1437, and at the Derby bank at about 1440 to 1443.

Lancashire No. 1 Bank, P. Barnes & Bro. The coal varies from about 3′ 3″ to 4′ 8″, with a slate parting of from one to two inches thick four inches from the bottom of the bed.

Colorado Bank, A. & W. Barlow. The coal is here from four to five feet, with one or two inches of slate from five to eight inches above the floor.

(*The Freeport Upper bed* (E) was worked forty feet above the Freeport Lower coal at the Glenwood bank, but is now abandoned. It is reported as from three feet to three feet four inches thick, with one inch of slate near the middle of the bed.)

At the Cody Ridge bank coal D shows about the same structure as at the Lancashire No. 1 bank.

At the Cuba or Leonard bank this coal is from three feet to three feet six inches thick, with one or two inches of bony on the bottom, which may represent the parting found in the Cody Ridge, Lancashire, and Colorado banks.

At the Derby bank the coal shows from four to over five feet of coal, with a one- or two-inch slate parting one foot from the floor of the bed.

(The Freeport Upper coal (E) has been opened about thirty-five feet above bed D, and is reported as being from three feet to three feet three inches thick, with one or two inches of slate six inches above the floor. This upper bed (E) has also been exposed thirty feet above the Cody Ridge bank, where it is reported from 3′ 0″ to 3′ 4″ thick.)

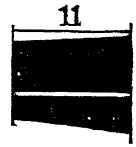
There is no question of the identity of coal D worked on the Derby Branch with that of the Morrisdale and Allport mines.

Going up the Morrisdale Branch railroad from Phillipsburg, we first pass the old abandoned Decatur banks. These are in a ravine on the north-west side of the railroad, and at elevations of 1440 and 1450 feet.

The new Decatur or Decatur No. 2 opening is about one mile north from these old banks, and the coal D is found at an elevation of about 1460 feet.

Coal D here shows a somewhat uneven floor which in places sinks down one foot or more, increasing the thickness of the lower bench to three feet. The bed commonly measures:

Slate roof of Coal bed D.	
"Bony,"	2" to 8"
Coal,	2' 6" to 3' 0"
Slate,	1" to 2"
Coal,	1' 3" to 2' 0"
Fire-clay floor.	

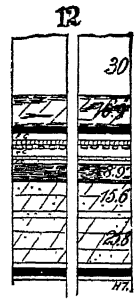


Passing on up the railroad to the Morrisdale mines, we find coal D at an elevation of about 1480 feet above tide.

Mr. William Wigton gives the following record of the rocks passed through in sinking a shaft to develop the Kittanning Lower Coal (Bed B.)

Morrisdale Shaft.—Mouth of shaft about eight feet above floor of coal worked in Morrisdale mines.

Surface,	30'	
Slate and Sandstone,	16'	9"
Coal (Bed C'),	2'	10"
Fire-clay,	3'	3"
Limestone, Johnstown Cement bed,	2'	5"
"Sulphur-balls" (carbonate of iron ?),	1'	10"
Fire-clay,	3'	4"
Sandstone,	1'	7"
Fire-clay,	2'	1"
Black Slate,	8'	9"
Coal,		9"
Sandstone,	15'	6"
Coal,		6"
Sandstone,	3'	3"
Coal,		10"
Gray Sandstone (fine-grained),	25'	8"
Fire-clay Slate,	3'	4"
Bony Coal,		5"
Coal,	4'	4"
Bone,		9"
Fire-clay,		
Total,	128'	2"



Adding above this section the data obtained from surface examinations, and generalizing the whole section, I obtain the following general section extending from the Mahoning Sandstone down to the Kittanning Lower Coal (Bed B):

Mahoning Sandstone, capping the hills here, soft and friable, probably shaly, and carrying a thin strek of coal near its base.		
Interval of shaly measures,		40′ to 50′
Freeport Upper Coal, (E,)		2′ to 2′ 6″
Fire-clay,	30′ to 35′	
Slate and shaly,		
Freeport Lower Coal, (D,)		4′ to 5′
Fire-clay,		2′ to 3′
Freeport Lower Limestone, about		2′
Interval,	22′	39′
Slate and sandstone, (in shaft,)	16′ 9″	
Kittanning Upper Coal, (C′,)		2′ 10″
Fire-clay,		3′ 3″
Johnstown Cement Bed, (limestone,)		2′ 5″
Fire-clay and sandstone, with ore,	8′ 10″	33′ 10″
Black slate,	8′ 9″	
Coal,	9″	
Sandstone,	15′ 16″	
Kittanning Middle Coal, (C,) Coal,	6″	4′ 7″
Sandstone,	3′ 3″	
Coal,	10″	
Sandstone,	25′ 8″	29′
Slate,	3′ 4″	
Kittanning Lower Coal, (B,)		5′ 6″

Condensing and generalizing this section, we obtain the following intervals, for "rough and ready use" in the field. (The *intervals* are given from the base of one bed to the base of the one beneath.)

Mahoning Sandstone.	
Interval,	40′ to 50′
Freeport Upper Coal—Bed E.	
Interval,	30′ to 40′
Freeport Lower Coal—Bed D.	
Interval,	40′ to 50′
Kittanning Upper Coal—Bed C′.	
Interval,	40′ to 45′
Kittanning Middle Coal—Bed C.	
Interval,	35′
Kittanning Lower Coal—Bed B.	

The interval from the base of the Mahoning sandstone down to B is about 195 to 200 feet.

The interval from D to B is 120 to 125 feet.

The Freeport Upper Coal (E) lies in the first bench above the Morrisdale openings. It is hardly thick enough to work at present.

Freeport Lower Limestone.--Mr. Wigton states that this limestone is found about three feet beneath the coal (D) worked at the Morrisdale mines and that some years ago it was mined from the old Decatur workings and burnt, but that it did not yield a first-class lime.

The Kittanning Upper Coal (C') reported as 2' 10" thick in the shaft at a depth of 56' 9", (42' 9" below Bed D,) is said to contain a thick central parting of slate. The bed also exhibits this structure where opened on the Stephen Kephart farm, two miles north-west from Osceola, and where prospected by Mr. Wigton on Muddy creek, south-west from Amesville. This is the same bed that is seen overlying the Johnstown cement bed in the railroad cutting near the terminus of Mapleton Branch R. R. No. 2.

The Kittanning Middle Coal (C) seems to be the most variable coal in the whole series throughout this basin. It is opened at very few places and is never worked; but some prospectors report finding from three to five feet of good coal at this horizon, but state that in short distances the bed is found to thin away or become so filled with slate, fire-clay, or sandstone partings as to be entirely worthless. Small workable areas of good coal may be found at this horizon, but the bed cannot be considered of much value in this basin.

The Kittanning Lower Coal, (B,) where pierced by the Morrisdale shaft, is reported as a good workable bed of clean coal four feet and four inches thick. It is not being worked at present and the shaft is now full of water.

The following data, extending to the end of this chapter, are here reprinted from Report H:

At *Penn colliery* at Houtzdale, D is opened on the north side of the Beaver Branch, about twenty-five feet above the creek level. The main entry goes in north. For the first 100 yards the roof and floor are comparatively regular, giving in different places from 42″ to 58″ (inches) of coal, hard, black, shining, and very clean. It shows:

Shales.		
Black Slate Roof,		2′ to 4′
Sandstone, persistent,		8″
Black Slate, hard,		1 to 2
Coal,	3′ 6	to 4 10
Fire-clay floor,		4

The coal breaks out in blocks, showing the columnar structure which characterizes this coal, and bears shipment well.

After the troubles begin, about one hundred yards in, the floor sometimes rises and cuts down the thickness of coal, or the roof descends, making only a crushed and useless mass of slate and coal. These troubles continue on with varying intensity to the main opening.

An average specimen shows, by Mr. McCreath's analysis, in the Laboratory of the Survey at Harrisburg:

Water,	.810
Volatile matter,	20.640
Fixed carbon,	74.023
Sulphur,	.507
Ash,	4.020
	100.000

Coke, per cent, 78.550. Color of Ash, white.

Analysis of the ash:

Silica,	2.040
Oxide of iron,	.350
Alumina,	1.140
Lime,	.136
Magnesia,	.032
Phosphoric acid,	.007
Sulphur,	. . .
Per cent of Ash in coal,	4.020

An analysis of coke made at this mine, roughly, in the open air, gives:

Water at 225°,	.600
Volatile matter,	2.020
Fixed carbon,	88.032
Sulphur,	.998
Ash,	8.350
	100.000

Coke yields a red ash.

"The coal is deep black, with shining luster, of a somewhat columnar structure."

At a distance of 2300 feet (north 15° west) from the main opening of the Penn mine, a drift has been run in on same bed. The same difficulties are encountered, the coal cutting down from 40″ to 12″, or less.

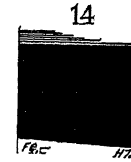
The same uneven fire-clay floor and black slate roof show here. In both openings the roof slates are filled with the impressions of the large plants common in the lower part of the Coal Measures and some ferns.

The Franklin colliery of the Kittanning Coal Company is opened on the south side of the Beaver branch at Houtzdale. It lies only about 20 feet above the creek, and the mine runs in about 800 yards to the south 16° east, the coal rising very gently to the south-east.

The superintendent of the mine reports the following section above the open bed:

Coal,	1′ 8″
Sandstone,	8
Coal,	10
Sandstone,	5 6
Black slate and thin sandstone layers,	2 6
Sandstone (visible) persistent,	6
Black slate,	1 6

Coal D, 58″ to 64″, (say 5 feet.)
Fire-clay floor.



An apparently clean upthrow of 10′ occurs in the mine at one place, obliging the company to cut through 10′ of their fire-clay floor, and some calcareous slaty nodules, for a distance of from 150 to 200 yards. The coal, however, was not injured nor cut down; but, when measured in different parts of the mine, ranged from 58 to 64 inches of

clear bright coal in one bench, without persistent slate partings.

An average specimen of this coal yielded, on analysis, (McCreath):

Water at 225°,	1.942
Volatile matter,	22.720
Fixed carbon,	71.018
Sulphur,	.543
Ash,	3.777
	100.000

Coke, per cent, 75.340.

The coal is bituminous, with bright shining luster and deep black color, somewhat columnar structure, very friable, and containing considerable mineral charcoal, also numerous small scales of calcite and a small amount of iron pyrites.

The coal does not swell much during coking, and forms a good coherent coke,* with a dull metallic luster, and yields a cream-colored ash.

The president of the Kittanning Coal Company has furnished a copy of an analysis of this coal, made for the company by Prof. Chas. A. Seely, chemist. The analysis corresponds closely with the general average of the coal of this part of the basin as determined by Mr. McCreath's analysis. It gives:

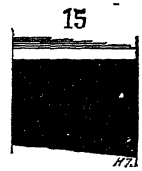
"Volatile combustible matter,	20.10
Fixed carbon,	76.39
Ash,	3.51
Coke,	79.09
Sulphur,	0.19

The small percentage of sulphur and of ash, as well as practical tests of the coal by coking and burning in various ways, indicate that for metallurgical purposes and for raising steam, it is of the first quality."

The Eureka colliery No. 1 is opened at Houtzdale on the north side of the Beaver Branch of the Moshannon Creek. The main entry runs in north, the coal rising gently to the north-west.

* In laboratory tests. H. M. C.

Black Slate,	3' to 4'
Sandstone,	6"
Black Slate,	1 to 2
Bony Coal,	6
Coal,	4' 6" to 5
Fire-clay Floor,	6



The roof and floor are very regular and undisturbed, the roof, however, rolling down in one place and cutting down the size of the coal for a short distance. There is also an occasional "swamp," but small and easily overcome. An average specimen of the coal yields by analysis (McCreath):

"Water,	0.78
Volatile matter,	21.680
Fixed carbon,	73.052
Sulphur,	.688
Ash,	3.800
	100.000

Coke, per cent, 77.540.

"Color of ash, gray. The coal is shiny black, very soft, with small seams of charcoal."

Analysis of ash:

Silica,	1.660
Oxide of Iron,	.560
Alumina,	1.360
Lime,	.134
Magnesia,	.046
Phosphoric Acid,	.013
Sulphur,	
Per cent of ash in coal,	3.800

The coal makes a handsome appearance in the mine, and is without persistent slate partings. The roof is excellent, and the coal mines well and bears transportation.

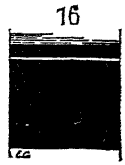
The company furnishes the following analysis of this coal made by Messrs. Booth and Garrett, chemists, as follows:

Moisture,	1.15
Volatile matter,	19.50
Fixed carbon,	77.05
Ash,	2.30
	100.00

From the Eureka mine the coal is rising to the northwest, and where opened at Houtzdale this Bed D is higher.

At the Webster Colliery No. 1 the coal showed the following section:

Black slate roof.
Coal, ... 0' 8"
Black slate, ... 1
Coal, ... 4 8
Fire-clay floor, ... 8" more or less.



The mine runs in to the north 60° west, and drains the coal rising gently but steadily to the noth-west.

A specimen of coal forwarded by the owners to Mr. McCreath, analyzed:

Water at 225° F.,	1.630
Volatile matter,	22.000
Fixed carbon,	72.815
Sulphur,	.425
Ash,	3.130
	100.000

Coke, per cent, 76.370.

"The coal has a bright resinous luster, is of somewhat columnar structure, and very friable. It contains numerous veins of bright crystalline coal and mineral charcoal, and shows very little iron pyrites. The coal swells but little during coking, yielding a good coherent coke * and gray ash with slight reddish tinge. If this sample fairly represents the mine, it shows a coal of very superior quality, and compares favorably with any yet examined here."

At the Diamond Mine, opened a few hundred yards further north, the coal shows this section:

Black slate roof.
Coal and bony coal, ... 0' 8"
Slate, ... 1.5 to 2
Coal, ... 4 10
Fire-clay floor.

From the measurements and the analysis, it is clear that coal bed D retains in this Houtzville region the same handsome size and high character displayed by it along the Beaver Branch at the Moshannon opening.

South-west of Houtzdale, Messrs. Kendrick & Company have been developing the coals. They report thus: "On the south side of the valley the Moshannon bed (D) is

* In laboratory tests. H. M. C.

found about 6 feet thick, with a dip of $\frac{2}{3}°$ to the southwest. There is a synclinal in a swamp, and on the rise of the measures a shaft was sunk through the following rock measures:

Surface stuff,	18′	
Shale, olive,	12	
S. S. hard bluish gray,	34	
Black shale,	5	
Coal, (with iron pyrites,)	0	8″
Parting.		
Black slate and poor coal,	3	
Parting.		
Coal,	2	9
Fire-clay floor.		

The above is the description given by the operators themselves.*

The Stirling colliery No. 1, of the Powelton Coal and Iron Company, is opened on the south side of the Beaver branch of the Moshannon creek, and about 20′ above the creek. The coal shows:

Roof, black slate,	2′	6″
Sandstone, persistent,	6	
Black slate,	1	
Coal,	5	
Fire-clay floor.		

The coal is in one bench, without regular and persistent slate partings, and is rising gently to the southeast. The roof is good and firm, and the coal mines out well.

The air shaft shows the following measures resting on top of the roof of slate in descending order:

Surface at top of air shaft.		
Small coal bed,	1′	
Slates, hard gray,	20	
Sandstone and slate,	5	
Slate,	2	
Sandstone,	1	
Slate,	0	9″
Sandstone,	0	6
Slate,	4	
Coal bed,	0	10

* The bed was subsequently found in good workable shape. H. M. C.

The small coal, 42' above the main bed, was opened up in another place near by where it was under cover, and found to yield from 30" to 36" of good coal. [It is Bed E.]

The main bed has a regular roof and floor; the only troubles in the mine being caused by a few small "swamps" easily overcome.

An average specimen of the coal shows by analysis, (McCreath):

Water,	0.710
Volatile matter,	23.400
Fixed carbon,	72.218
Sulphur,	0.532
Ash,	3.140
	100.000

Coke, per cent, 75.890. Color of ash, gray with red tinge.

"The coal is black, columnar, and contains scales of iron pyrites."

The old Moshannon mine of the Moshannon Lumber and Mining Company, is opened on the south side of the Beaver Branch, about 1½ miles below Stirling, and 3 miles southwest of Osceola.

Roof, black and grayish slates,	10'
Coal,	5' 3" to 5' 6"
Fire-clay floor,	3 or more.

The coal shows clear and bright in one bench, without any persistent slate partings.

In driving off east from the main entry at about 150 yards' distance, a serious trouble was found. The coal dips suddenly downward, say 5 feet in a distance of 30 feet. Then what appear to be the roof slates of the coal, rest directly against the coal itself, in a clean fracture. Some 7 feet below, a 15-inch coal is found with black slate roof and fireclay floor complete. A shaft from the surface some 15 yards east of the present (July, 1874,) workings, found the same thing, 15 inches of coal. The workings had therefore been carried no farther in that direction than the line of fault. [This is only one of the series of faults described elsewhere in this report. They were not discovered or defined at the time this first report was prepared.]

An average specimen of the coal from the Moshannon mine (Bed D) yielded on analysis, as follows, (McCreath):

Water,	.765
Volatile matter,	20.090
Fixed carbon,	74.779
Sulphur,	.666
Ash,	3.700
	100.000

Coke, per cent, 79.145. Color of ash, gray with reddish tinge.

"The coal is black, shining, friable, contain much iron pyrites and charcoal."

Bed E.—About thirty-five feet above D there is an old opening on a small coal bed, now fallen shut, which is reported as having given thirty inches of good coal (Bed E).

Bed C'—The superintendent reports that on sinking a well on the flat just below the mine (twenty-five feet lower), a coal was struck twenty feet below the surface, making a coal* forty-five feet below.

The coal beds in this section are only opened up on the outcrop, excepting bed D, which was opened for mining.

This opening on D showed:

Roof slates, gray and black,	6
Black slate and bony coal,	0 6″
Coal,	5 8
Fire-clay floor,	2 to 3

19.

The coal where examined was in one bench, without regular and persistent slate partings.

An average specimen of the coal yielded by analysis (McCreath):

Water,	1.100
Volatile matter,	23.070
Fixed carbon,	71.199
Sulphur,	.611
Ash,	4.020
	100.000

Coke, per cent, 75.830. Color of Ash, red.

"The coal has rather a dirty appearance, is friable, and contains considerable Iron Pyrites."

The president of the Moshannon Coal Company, Mr. D. Knight, furnishes the following analysis of this same coal,

*Evidently the Kittanning Upper Coal, Bed C'.

made by Messrs. Booth and Garrett. The two analyses, it will be seen, agree quite closely:

Water,	1.100
Volatile matter,	22.450
Fixed carbon,	72.300
Ash,	4.150
	100.000

The Beaverton mine which was opened and worked just south-west of the Moshannon mine (on the adjoining tract) is now abandoned. The coal is said to have shown about the same thickness.

The old Decatur mine opened near the head of Coal Run is also abandoned and fallen shut, and affords no opportunity for measurement. It is reported that the mine was faulty and abandoned for that reason. [It has since been re-opened, and is now known as the Arctic colliery.]

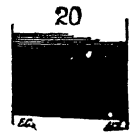
Bed D is opened on the hill top, back of Osceola, and is worked in a small way to supply the village. There are also some old farmers' openings round the neighborhood.

Langdon's colliery, about one mile north-east of Osceola, was not working when the district was examined, and no specimens were taken from it. The coal is run down a tramroad to Dunbar station, on the Tyrone and Clearfield Railroad, for shipment. The mine is opened 125 feet above the Moshannon, and the hill rises forty-five feet above, taking in near the top the small coal bed (E) which everywhere overlies bed D through this country, about thirty-five feet above it.

At Hale's colliery, about one half mile north of Langdon's mine, both beds D and E are opened. The mines lie about one mile north of Osceola, and are on the south side of Shimmel's Run. A small branch connects the mine with the Mapleton Branch Railroad, and by that with the Tyrone and Clearfield Railroad.

The lower bed D shows the following:

Roof, black slate, tough.
Coal, ... 3' 8'' to 3' 10''
Fire-clay floor.



The black slate roof, though tough and strong, is very irregular and unquiet, coming

down frequently and pinching the coal down to eight or ten inches of thickness. This irregularity begins almost at the mouth of the mine and continues at intervals up to the end of the main entry.

An average specimen of this coal D yields on analysis (McCreath):

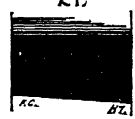
Water,	0.740
Volatile matter,	25.210
Fixed carbon,	68.628
Sulphur,	2.122
Ash,	3.300
	100.000

Coke, per cent, 74.050. Color of Ash, red.

"The coal is bright, shining, columnar, containing veins of Iron Pyrites."

Bed (E) thirty feet above, shows the following section:

Roof, black slate, crumbly.
Coal, ... 3' 2" to 3' 6"
Fire-clay, ... 1 6 or more.



The roof is poor, but is regular, lacking the rolls and pinches of the bed below.

An average specimen of this coal E yields by analysis (McCreath):

Water,	0.570
Volatile matter,	24.630
Fixed carbon,	68.400
Sulphur,	1.900
Ash,	4.500
	100.000

Coke, per cent, 74.800. Color of ash, gray, with red tinge.

"The coal is bright, shining, columnar, contains small veins of iron pyrites."

Back of the mines, 65 feet by barometer above the upper bed, the surface is covered with lumps and small bowlders of hard sandstone, fine grained, slightly conglomeratic in places. This is the *Mahoning sandstone.*

Mapleton Colliery is opened on the south side of Shimmel's Run, 1 mile north of Osceola. The mine runs in to the south, the coal rising slowly to the north-west. The coal D shows here:

Gray slates and thin shales.
Black slate, ... 2' 6
Bony coal, with small coal layers, ... 0 7½
Coal, ... 3 11
Fire-clay, ... 1 6
Sandstone.

22.

The coal is one bench, from 3½ to 4 feet thick, without persistent slate partings, and very tender, breaking up easily.

An average specimen of the coal yielded (McCreath):

Water at 225°,	0.700
Volatile matter,	23.565
Fixed carbon,	68.890
Sulphur,	1.715
Ash,	5.130
	100.000

Coke, per cent, 75.735. Does not swell much during coking, forms a coherent coke and yields a gray ash.

An analysis of the ash gives, (McCreath):

Silica,	1.675
Oxide of Iron,	1.570
Alumina,	1.480
Lime,	.221
Magnesia,	.154
Per cent of ash in coal,	5.130

The coal is bituminous, with bright shining luster, columnar structure, very easily broken, contains small scales of iron pyrites.

As is usual at most of the mines, some of the small coal had been roughly coked in the open air near the mine mouth. The coking was very imperfectly done; and an average specimen of the coke yielded (McCreath):

Water at 225°,	.580
Volatile matter,	1.370
Fixed carbon,	84.068
Sulphur,	1.032
Ash,	12.950
	100.000

Has dull luster, on fresh surface brignt, shining luster, shows much iridescence, and contains considerable slaty matter. Yields a red ash.

The undue proportion of ash in the above analysis shows how carelessly the coking is conducted, and how much bone and slate are put on the hearth with the slack coal.

The mine has an excellent tough black slate roof, and both floor and roof are even and regular.

The bench of the overlying bed E shows thirty-five feet above on the hill side, with about fifteen to twenty feet of cover (shales) to hill top.

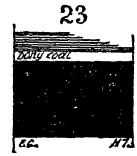
About thirty feet below the Mapleton bed (D) is a small coal bed (C'?) not opened so as to be measured.

The Mapleton bed has also been opened on the outcrop on the north side of Shimmel's Run, and shows there as well as in the Mapleton mine.

The Logan colliery is opened on the north side of Shimmel's Run, about one and one half miles north of Osceola. The mine runs in about north 5° east, and the coal has a gradual, very gentle dip towards the south east.

Coal D here shows:

Shales.	
Roof, black slate, tough,	3'
Bony Coal,	6''
Coal,	3 10
Fire-clay floor.	



The coal measured three feet eight inches to four feet of good bright coal, in one bench, without regular slate partings, usually rather tender.

An average specimen of coal yielded (McCreath):

Water at 225°,	.620
Volatile matter,	22.135
Fixed carbon,	68.728
Sulphur,	.867
Ash,	7.650
	100.000

Coke, per cent, 77.245.

The coal is bituminous with dull luster, somewhat columnar in structure, with thin veins of coal running through it. The coal forms a good coherent coke, with shining luster. It yields a gray ash.

An analysis of ash yielded (McCreath):

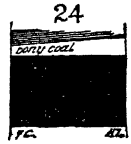
Silica,	3.493
Oxide of iron,	.750
Alumina,	2.700
Lime,	.302
Magnesia,	.168
Phosphoric acid,	.237
Per cent of ash in coal,	7.650

Thirty-five feet above the Logan mine the upper bed E is opened up on the outcrop. The section shows:

Hill top.
Shales, ... 15'
Black slate roof.
Coal, E, 2 to 2' 6"
Fire-clay floor, bottom not seen.

The Laurel Run colliery (Nuttall & Bacon) is opened on the north side of Shimmel's Run, 1¾ miles north-west of Osceola. Coal D here shows:

Black slate roof.
Bony coal, 6" to 12"
Coal, 3' 10" to 4'
Fire-clay on floor, 3 6, or more.



The coal is in one bench, bright and clean, free from regular and persistent slate partings, and is tender, breaking up easily.

An average specimen of this coal yielded (McCreath):

Water at 225°,	.800
Volatile matter,	23.260
Fixed carbon,	72.350
Sulphur,	.590
Ash,	3.000
	100.000

Coke, per cent, 75.940.

The coal is bituminous, with bright shining luster, columnar structure, containing small scales of iron pyrites. It forms a porous, friable coke, with shining luster. Yields a red ash.

An average specimen of the coke, made roughly in the open air near the mouth of the mine from the coal slack, yielded (McCreath):

Water,	0.510
Volatile matter,	1.300
Fixed carbon,	89.243
Sulphur,	.607
Ash,	8.340
	100.000

Color of ash, reddish.

The coke has a silvery luster, and is very compact.

Reese's mine is opened 2½ miles north of Osceola. The coal shows:

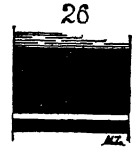
Roof, black slate and bone coal.
Coal, ... 4' 6"
Black slate, ... 1 to 3"
Coal, ... 6
Floor, not seen.

The coal is bright, clean, and hard, and shows very little iron pyrites. The roof and floor are hard, good, and entirely regular and undisturbed. The mine is only opened for farm use, having no railroad connection, and making no shipments. The coal at this point appears to be at its very best, both in size and quality.

The Derby colliery is opened on the north-west side of the Moshannon creek, opposite Phillipsburg. Two coal beds are opened 30 feet apart. The mines run in to the westward, the coal sinking gently to the south-east.

The lower coal opening on bed D showed:

Roof, black slate.
Coal, ... 3' 4"
Slate parting, ... 4
Coal, ... 8
Fire-clay floor, ... 1 6 or more.



An average specimen of coal D yielded on analysis, (McCreath):

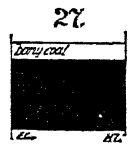
"Water,	0.41
Volatile matter,	22.81
Fixed carbon,	66.69
Sulphur,	1.79
Ash,	8.30
	100.00

Coke, per cent, 76.78. Color of ash, gray, with pink tinge.

"The coal is bright, columnar, friable, and contains small veins of charcoal."

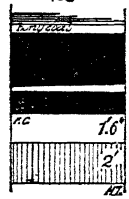
Thirty feet of shales and thin sandstone separate Bed D at this opening from the bed [E] above; nodular calcareous masses showing in the shales, just below the fire-clay floor of the upper bed.

The mine is now fallen shut and cannot be measured: it is thus reported:



Bony coal,	0 10'
Coal,	3 8
Fire-clay floor,	2 or more.

The Decatur colliery is opened about 1 mile north-west of Phillipsburg. The coal shows:



Shale. Slate. } Above the Bed D.	
Coal,	1' 2"
Shales,	10
Sandstone,	0 9
Shale and slate,	1 9
Bone coal,	0 5
Coal,	2 10
Slate parting,	1 to 4'
Coal,	1 2
Fire-clay,	1' 6" to 2
Limestone,	2
Sandy slates in bottom.	

The main entry runs in north-west, and the coal dips very gently to the south-east.

The coal is hard, brilliant black, comes out well in blocks, apparently with but little sulphur.

Lower bench.—An average specimen of coal from the lower bench yielded (McCreath):

Water,	0.640
Volatile matter,	24.360
Fixed carbon,	64.082
Sulphur,	3.378
Ash,	7.540
	100.000

Coke, per cent, 75.00. Color of ash, gray, with pinkish tinge.

An analysis of the ash of the Lower bench gives:

Silica,	2.100
Oxide of iron,	3.550
Alumina,	1.550
Lime,	.090
Magnesia,	.206
Phosphoric Acid,	trace.
Sulphur,	—
Per cent of ash in coal,	7.540

Upper bench.—An average specimen of the coal from the upper bench yielded (McCreath):

Water,	0.820
Volatile matter,	23.900
Fixed carbon,	69.007
Sulphur,	1.373
Ash,	4.900
	100.000

Coke, per cent, 75.28. Color of ash, gray, with pinkish tinge.

The coal has a bright, shining luster, and columnar structure like that of the Lower bench.

An average specimen of coke, made in the open air from the coal slack, yielded (McCreath):

Water,	0.350
Volatile matter,	2.190
Fixed carbon,	90.293
Sulphur,	.867
Ash,	6.300
	100.000

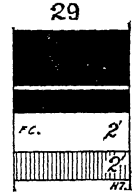
Color of ash, red.

The coke is dull gray on outside, silvery on fresh fracture, compact, and contains considerable slate.

Bed E. 35 feet above this coal a small bed has been opened. It is now fallen shut, and is reported as a "30 inch coal," of good quality. Rusty shales thin, overlie this upper bed for 25 feet to the hill top.

The Morrisdale colliery is opened on both sides of a small branch, and 3 miles north-west of Philipsburg. Here coal D shows:

Grayish tough slate.	
Bony coal,	6'
Hard slate,	1' to 3
Coal,	3
Slate, not sandy,	0' 3" to 0 1"
Coal,	1 1½
Fire-clay,	2
Limestone, [Freeport Lower,]	2' not seen.



The coal from both the upper and lower benches comes out hard, bright, and clean. Some few knife edges of slate come in at intervals, but none persistent.

Lower bench.—An average specimen of the lower bench of the coal yielded (McCreath):

Water,	0.55
Volatile matter,	24.09
Fixed carbon,	71.689
Sulphur,	.571
Ash,	3.10
	100.000

Coke, per cent, 75.36. Color of ash, gray.

The coal is bright, shining, columnar, and free from visible iron pyrites.

An analysis of the ash yielded (McCreath):

Silica,	1.450
Oxide of iron,	.350
Alumina,	.500
Lime,	.260
Magnesia,	.198
Phosphoric acid,	.047
Sulphur,	.054
Per cent of ash in coal,	3.100

Upper bench.—An average specimen of the main upper bench, gave (McCreath) on analysis:

Water,	0.56
Volatile matter,	25.19
Fixed carbon,	71.013
Sulphur,	.587
Ash,	2.65
	100.000

Coke, per cent, 74.25. Color of ash, salmon.

The coal is bright, shining, contains considerable iron pyrites, breaks into plates.

An average specimen of coke, made roughly in the open air, from coal slack, yielded on analysis (McCreath):

Water,	0.250
Volatile matter,	0.730
Fixed carbon,	90.707
Sulphur,	.643
Ash,	7.670
	100.000

Color of ash, red.

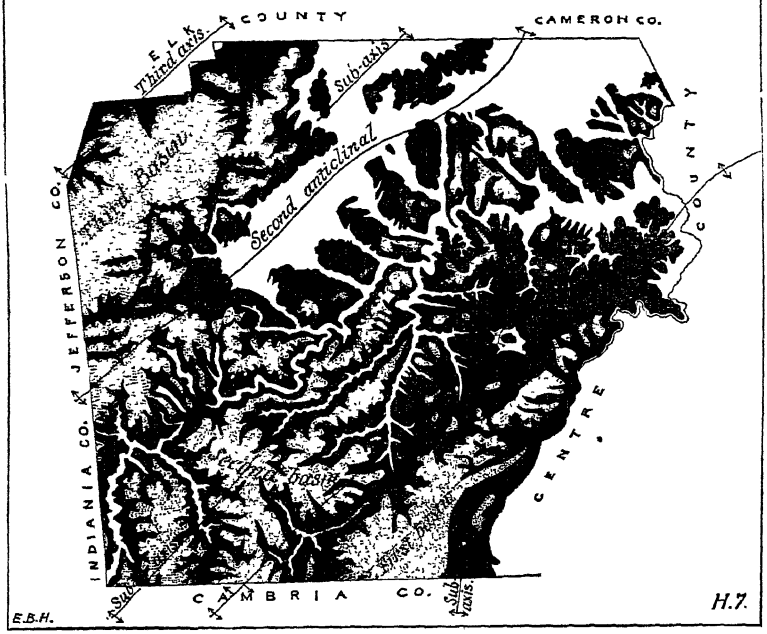
The coke is coherent, compact, with gray luster, containing considerable slate.

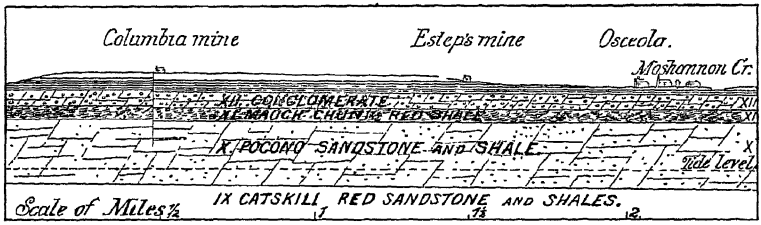
Here the extracts from Report H end.

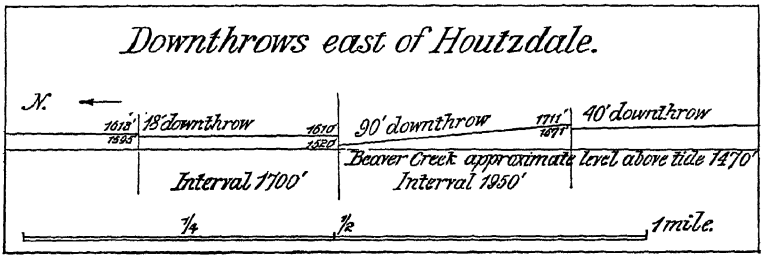
80. H7

Map of Clearfield County Coal Measure Outcrops.

The areas left white are No XII; those dotted, Mahoning Sandstone.







PART II.

GEOLOGY BY TOWNSHIPS.

1. Gulich Township.

This forms the south-east corner of Clearfield county. Cambria county forms its southern and Centre county its eastern line. Woodward township lies north and east of this township, and Muddy Creek separates it on the west from Beccaria township.

As the central line of the Houtzdale-Phillipsburg basin crosses it from north-east to south-west, passing one mile and a half north-west of Janesville, and north-west of Ramey, the prevailing dip throughout the central and eastern parts of the township is toward the west and north-west. In the north-western part of the township the coals dip strongly to the south-east.

A narrow anticlinal fold, dying out to the north, apparently passes through the eastern part of the township.

Along the central line of the basin, from Ramey south-west, we find the Barren measures occupying all of the high land, and in the south-western part of the township these rocks also form much of the land lying at a lower level.

Other details of the geology of this township will be found in Chapter V of Part I.

2. Woodward Township.

In the central portion of this township the coals dip to the south-east towards the center of the Houtzdale basin, which nearly coincides with the course of Beaver Run. On the south side of Beaver Run the coals rise to the east, and Bed D outcrops on the ridge between Beaver Run and the Moshannon.

As this bed is again found near water-level, with a strong north-west dip in the south-eastern corner of the township, it is evident that the coal is again thrown down by a fault, or, more probably, by an anticlinal axis coming in from Gulich township.

The Freeport Lower Coal bed (D) rises steadily from the basin at Houtzdale towards Amesville; but here the dip changes and the coal is found dipping towards Clearfield creek, but this dip continues only for a short distance.

The northern part of the township is occupied by Coal Measure rocks, but only the highest knobs are high enough to catch the Freeport Lower coal, and the Mahoning Sandstone is seen on only one or two of the highest summits.

North-west from Jeffries P. O. Cross-roads the bench of the Freeport Lower coal is seen at an elevation of about 1850 feet above tide. The dip here is very strongly to the north-west, so that on the next summit, and only one half mile or thereabouts distant from where the Freeport Lower coal is seen, the Mahoning Sandstone comes in at an elevation of 1850 feet above tide.

In the vicinity of Amesville, and north-east along the divide between the waters of Clearfield creek and the Moshannon, the Mahoning Sandstone is constantly seen. All the coals, from Bed B up to Bed E, have been opened by prospecting shafts and drifts at several places on the headwaters of the Upper Morgan run.

The First Anticlinal axis passes through the township from north-east to south-west, crossing Upper Morgan run near the junction of the south and north branches, where the Clarion Sandstone lies 1595 feet above tide, and the top of the Conglomerate, No. XII, is seen at an elevation of about

1535 feet above tide, or about 235 feet above water-level in Clearfield creek. The Mahoning Sandstone here lies in the summits on the axis at an elevation of 1800 feet above tide.

About one mile and a half or two miles below Madera bed B has been opened near the creek at an elevation of about 1500 feet (200± above water-level), but the opening is now closed. It is reported as showing 5′ 6″ of coal.

A section of the measures at Madera given in Report H can be readily harmonized with those compiled in the first and second basins, thus:

Shales in hill top, 20′
Small bench and smut, ... —
Shales, 55′
} Place of Mahoning S. S. in upper half of this interval.

Bench reported once opened, 6′ coal (Bed E.)
Thin sandstones and slates, ... 40′
Bench not opened (Bed D).
Shales buff and brown, with a little lean hematite ore in small pieces, . 31′
Fire-clay (reported), ... 9′
Black slate, ... 5′
Coal not opened, (C′) called, ... 5′(?)
Shales and slates, ... 41′
Slates, hard and dark, covered with nodular carbonate iron ore, ... 9′
Black slate, ... 5′
Coal not opened, (C) called, ... 4′
Sandstone, ... 26′
Coal (B), ... 4′
Sandstone, (this interval nearer 60′), ... 30′
Coal reported at creek level (A), ... 4′(?)

3. *Decatur Township.*

This township lies almost entirely in the First or Houtzdale-Philipsburg basin, and the prevailing dip is therefore south-east.

The First Anticlinal axis cuts across the north-western corner of the township, elevating the Freeport coals to about

2000 feet above tide. Along the eastern part of the northern edge of the township the lower coals occupy the surface at elevations of from 1800 to 2000 feet.

A line drawn from Jeffries P. O. Cross-roads east by north, so that the eastern extremity of the line will about coincide with the course of Beaver Run, divides the more valuable coal land on the south-east from the area containing only the lower beds and small patches of the Freeport coals on the north-west.

A strong north or north-west dip pervades the north-western corner of the township, and in the high land one mile north of Jeffries Cross-roads P. O. we find the Mahoning Sandstone in a ridge close to the township line in Woodward township.

The more important details of the geology of this township will be found in the description of the Houtzdale-Philipsburg basin in chapter V of Part I.

A well was drilled for oil on the flat opposite Philipsburg in the spring of 1861. The following record was kindly furnished by Dr. Allport of Philipsburg. The mouth of the well was located about forty feet, more or less, below the Moshannon (D) coal.

"Earth and ore,	8′—	0 to 8
Brown sandrock,	11′—	8 to 19
Gray sandrock,	28′—	19 to 47
Gray sand,	28′—	47 to 75
*Blackslate, mixed with coal,**	4′—	75 to 79
*Black sand rock,**	2′—	79 to 81
*Black slate mixed with coal,**	3′—	81 to 84
White sandrock,	2′—	84 to 86
Gray sandrock,	8′—	86 to 94
Black sandrock,	9′—	94 to 103
Black slate,	15′—	103 to 118
Fire-clay,	3′—	118 to 121
Black slate rock,	35′—	121 to 156
Hard bituminous coal,†	7′—	156 to 163
Fire-clay,	10′—	163 to 173
Gray sandrock,	6′—	173 to 179
Fire-clay,	2′—	179 to 181
Gray sand,	3′—	181 to 184
Common slate rock,	4′—	184 to 188
Sandrock,	5′—	188 to 193
Slate rock,	2′—	193 to 195
Blue sandrock, very hard,	6′—	195 to 201"

* Evidently Bed B. † Bed A.

4. *Morris Township.*

This is one of the largest townships in the county. It lies east from Graham, Boggs, and Decatur townships, and is separated on the south from Centre county by the Moshannon creek.

In the southern part of the township the Morrisdale, Decatur, Pardee, and Allport collieries are working the Freeport Lower coal, but the basin is shallow and flat, and is rising towards the north-east, so that this coal leaves the hills a short distance from Morrisdale town, the summits near Kylertown not being quite high enough to catch it.

The Houtzdale-Philipsburg basin may therefore be considered as terminating a short distance east of Morrisdale.

Going south-east from Kylertown towards "The Shelvings," the measures lie very flat, presenting no indication of the presence of either an anticlinal or synclinal flexure.

On the road leading north from Kylertown we find a gentle anticlinal roll running apparently north-east, but the exact crest of the axis and its course at this point cannot be accurately located. It apparently crosses the road at the cross-roads near the white school-house. This is the eastward extension of the Wallaceton axis, and doubtless continues north-east to Centre county, thence north-east to the Hyner axis, in Clinton county where it is a well-defined flexure.

Many details of the geology of this township, especially the south-eastern part, will be found in the chapter devoted to the Houtzdale-Philipsburg basin.

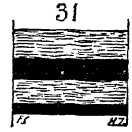
One half mile south of Kylertown two beds of coal are opened at elevations of about 1595 and 1555 feet above tide. The lower bed appears to be bed B and the upper bed C, which would make the limestone reported at Kylertown, the Johnstown cement bed, and the coal above it would be the Kittanning Upper coal (Bed C').

This identification would force us to consider Kepple's bank in Graham township as opened on bed B.

The Mon's bank (lower bed at 1555') is reported in H as follows :

"Black slate roof,	5	
Cannel slate,		8"
Coal,	1'	2"
Cannel slate,	1	3"
Coal,		6"
Fire-clay floor, hard.		

31



"The coal is hard and has a cannel look, but is, in no respect, a cannel coal. An average specimen analysed (McCreath):

Water,	0.750
Volatile matter,	19.570
Fixed carbon,	69.833
Sulphur,	.677
Ash,	9.170
	100.000

"Coke, per cent, 79.68. Color of Ash, gray, with reddish tinge. The coal is dull, with resinous luster, very compact and hard."

"Where the coal is again opened, some 200 yards away, the cannel appearance has entirely disappeared, and the coal shows simply an ordinary and rather soft bituminous coal."

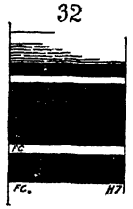
"The bed (C) opened 35 (40) feet above shows only 18 inches of coal."

Bed B is also opened at J. Mon's place, north-east from Kylertown, where it shows a similar structure to the measurement obtained at the old Beam's place.

At Beam's place I measured:

Shaly slate reof coal,		7"
Slate and bone,		4"
Coal,	3'	3"
Fire-clay shale,		6",
Coal.	1'	6"
Fire-clay floor.		

32



This bed has been opened at several points in the vicinity of Moravian Run, and is commonly reported as showing substantially the structure, but as we approach the Moshannon creek the lower parting thickens, so that on the Centre county side it has been found to reach eighteen inches, and this thickening is at the expense of the lower bench of coal which in some places thins down to about six inches.

In some prospecting shafts on Moravian Run, the bed has been found eight feet thick with not more than six inches of parting, but such a development of the bed is doubtless of limited extent.

This is the bed now being opened by Mr. Platt for the Clearfield Bituminous Coal company, and from which they expect to ship a large quantity of coal.

Going north-east towards the mouth of the Moshannon, the measures rise gently towards the First anticlinal axis, but this rise is sufficient to carry Bed B up into the air, so that no considerable area underlaid by it is found beyond the red school-house. The ridge road here runs on the Clarion sandstone.

At Beam's place the coal (B) is about 1560 feet above tide, and the top of the Conglomerate * (No. XII) is about 1500 feet above tide, here apparently lying on the crest of the First anticlinal axis.

A shallow basin, broad, flat, and not well-defined, apparently begins at a point east of the road leading from Kylertown to the "Shelvings," and runs north-east towards Centre county.

At creek level at Peale the Red Shale of No. XI apparently lies a few feet above water level near the new bridge. It probably continues above water level from this point down to the mouth of the Moshannon.

At Peale there is quite a perceptible west dip, at least such a dip prevails in the immediate vicininity of the creek, so that as we go up the Moshannon we find the Conglomerate measures coming down until they pass beneath water level near where the road running south-east from Morrisdale town crosses the creek. About one half mile east of this point a bank was opened many years ago on Bed B, at an elevation of about 1465 feet above tide. The bank is now closed and cannot be entered. It is said that the bed showed six feet of coal. It has a strong west dip towards the center of the Morrisdale basin.

The Hawk Run Bank is opened on a lower bed than Bed

* Exposed along the road near the small run flowing into Basin Run.

D. Many think this bank is located on Bed B, others hold it to be on the "Slate vein" or Bed C'. It is located such a short distance from the Empire and Pardee banks that its identification with Bed B involves the assumption of a west dip of at least 90 feet in half a mile, or the presence of a fault of some magnitude, in order to obtain the demonstrated interval of 120 feet that exists between Beds D and B. The assumption that it is located on the Kittanning upper Bed, (C',) is supported by the apparent dip of the measures, and also by the structure of the coal. More information than we now possess of this vicinity is needed before we can feel entire confidence in either hypothesis.

The Brookville coal, Bed A, has been opened at several points by Messrs. Platt and Hopkins of the Clearfield Bituminous Coal company, and was worked at several county banks many years ago. These banks are in the eastern part of this township, and are now nearly all fallen shut.

The bed commonly shows about two and a half feet of coal without any parting, but has been found at a few points to measure three and even upwards of four feet, but its development as a bed of workable thickness is doubtless of limited extent. It occurs from 70 to 100 (?) feet below B.

An Intra-Conglomerate coal has been found at several places on the Clearfield Company's tracts. It lies about 60 to 80 feet below Bed A, and is about fifteen or eighteen inches thick.

A coal, probably Bed A, is reported by Mr. A. Ralston as having been passed through in his well at a depth of about fifteen feet. Mr. Ralston states that the coal was four feet thick, without slate or sulphur. It lies about 1480 feet, more or less, above tide.

The site of the Clarion sandstone in this township is often, in fact generally, occupied by very fair farming land. The rock rarely makes a bold show, and the country often appears to be underlaid by higher measures. The rock overlying Bed B here frequently resembles the Clarion sandstone, and is a decided obstacle in tracing the coal by means of the latter rock.

[The following facts are reproduced from Report H.]

The coal beds have been shafted on or drifted into in three places, all within a moderate distance north-east and north-west from Morrisdale. The first opening shows :

Black slate roof.		
Coal smut,	1′	
Coal,	1	6″
Shale,	0	7
Coal in sight,	1	6

The lower bench is reported as showing 3′ 6″ more when fully exposed, or 5′ in all. This full thickness was not seen, but the authority for the statement is reliable.

The coal lies apparently about forty feet from the top of the Conglomerate, a small smut showing on the road-side twenty feet below it.

This outcrop opening speaks very favorably for the bed.

Near this point (at head-waters of Crawford Run) a bed of coal was opened many years ago, but is now fallen shut. The blacksmith reports it as working well in his fire, and as being "six feet thick." There is no way of judging surely, but this should be bed A of the First Basin section.

Going south-west from this point the basin deepens, taking in higher coal lands. At Keffer's mine, one half mile west of Kylertown, the coal shows :

Black slate roof, good.	
Coal,	9′
Slate,	4 to 6″
Coal, good,	3′ 3
Fire-clay floor.	

The coal looks and mines out well. The measures are dipping gently to the south-east, the mine being on the north-west side of the First Basin. The bed looks much like coal bed B of the First Basin section.

Mr. J. Potter opened up a coal bed on his place, one half mile north-east of Kylertown, and coal has also been opened on A. Brown's place, on the head-waters of Grass Flat Run. Two workable beds are reported at the latter place, separated by only twenty feet of measures.

Limestone was once opened at Kylertown (only a few feet

above the road), but it contained too much iron to burn well for agricultural purposes. Over the limestone is a small coal smut.

5. *Beccaria Township.*

This is a large irregular area lying in the southern tier of townships adjacent to Cambria county. Muddy Run forms its eastern boundary, and Chest, Jordan, and Knox townships lie on its western and northern borders.

It lies almost wholly in the First Basin. The First anticlinal apparently runs close to its north-western border, and the prevailing dip is to the south-east towards the line of the First Basin, which crosses the township from north-east to south-west, passing near Utahville.

Local west and north-west dips will be found in the area east of Clearfield creek, and the Amesville sub-axis will probably be found to exist as far south as Coalport.

By reference to the Geological Map it will be seen that the south-eastern part of the township is occupied by the Barren measures; that the top of the Conglomerate, No. XII, is above water-level from near Glen Hope to Coalport, and that the Lower Productive coal measures occupy the remainder of the surface. I was not able to determine the exact points at which the Conglomerate, No. XII, sinks beneath water-level on Clearfield creek.

The Gallitzen coal has been opened in the neighborhood of Utahville, and found to be from two to three feet thick. It is not worked at present.

The Freeport coals in this vicinity lie buried in the basin beneath a thick covering of Barren measures (200 feet or more from the summits down), so that they are practically inaccessible. As we go west towards Clearfield creek these coals come up into the hills; but the openings made upon them have shown only from two to three feet of coal.

There seems to be a better prospect of finding them of workable thickness east of Utahville, in the Muddy Run

district, but they may there lie too deep to be mined at present.

Kittanning coals.—Prospecting openings at the horizon of the Kittanning Upper coal have been made in the vicinity of Glen Hope, where this bed is probably about three feet thick.

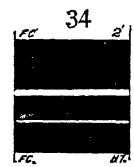
The Kittanning Middle coal has been opened by prospecting shafts and drifts near Coalport, where Mr. Gaskin reports it as showing forty-two inches (3′ 6″) thick, and near the mouth of Witmer Run, where it is reported as being three feet thick.

The Kittanning Lower coal (Bed B) is opened and worked at a number of banks near Coalport. It lies from ninety to over one hundred feet above water-level. At the new opening of the Irvonia Coal Company (Gaskin, Laycock & Co.) the bed shows :

Rock-roof (reported).
Fire-clay roof (reported 2½ feet thick).

Coal,	2′ 6″ to 2′ 10″
Bone,	3″ to 6″
Coal,	1′ 1″ to 1′ 3″
Slate parting,	1″ to 1½″
Coal,	1′ 4″ to 1′ 6″

Fire-clay floor.



The coal here lies ninety-six feet (so stated) above the creek, and forty feet below the Kittanning Middle coal (Bed C). A three-foot coal, which is probably the Freeport Upper coal (Bed E), is reported as having been opened and worked some years ago at an elevation of 186 feet above this (Bed B) coal.

The "Sykes and Jones'," "Elliott's," and "Bryson and Richard's" banks were closed at the time of my visit, the miners being out on a strike. I am informed that they show a larger amount of refuse than the Gaskin, Laycock & Co. opening; that the "bone" is commonly from six to ten inches thick, and sometimes replaced by three or four thin slate bands lying close together.

The Brookville (?) coal Bed A has been opened by prospecting holes a short distance above water-level near Coalport, but I could obtain no information respecting its size or quality that I considered reliable.

This is apparently the bed opened one mile and a half west of Glen Hope, at the junction of the two roads leading south-west from the town, but this opening may be on bed B. It shows three feet of rather sulphury coal, and appears to be pinching down to a smaller thickness. Bed B was opened several years ago by Mr. Patchin at Glen Hope, where the bed is reported as being three feet six inches (42") thick. The coal dipped into the hill and the opening was abandoned and has long since fallen shut.

The Freeport Lower (?) Limestone has been quarried at Dr. Caldwell's place on the hill overlooking Glen Hope, where Mr. Platt obtained a sample that yielded by analysis (McCreath)—Report H:

"Carbonate of lime,	93.810
Carbonate of Magnesia,	1 710
Sulphur,	.053
Phosphorus,	.008
Insoluble residue,	2.070

"The limestone is hard, compact, crystalline, and of a bluish-gray color."

I am informed that at a coal bank near by, opened on a bed only two feet thick, the coal was underlaid by about two feet of fire-clay and beneath this they found the limestone.

Glen Hope.—A number of old banks can be found in the region lying south-west of Clearfield creek. They are located on the Kittanning upper and the Freeport beds, but nearly all of them are fallen shut and the coal cannot be measured. However, as the owners do not claim more than from two and a half to three feet of coal, this is not a matter of much importance.

Recent prospecting in the hill opposite Glen Hope has shown the existence of over four feet of coal. This opening is in the woods, and as I could not find it, I am not prepared to say what bed the opening is made on, but am inclined to think it is located on bed B.

The Freeport Lower coal, Bed D, is reported as having been found of good thickness near the mouth of Muddy Run, but the bed here lies high in the hills with very little

cover. Going south, up Muddy Run, the bed rapidly descends towards the axis of the First basin. Much prospecting has been done in this area, but no large workable bed has yet been found.

The Mahoning sandstone caps the summits along the western border of the township. It is also seen in the hills east of Coalport, but going east towards Utahville it soon passes down beneath a thick covering of Barren measures, so that the lower or principal member is hidden from sight, the upper member lying near water-level at Utahville.

The geology of the neighborhood may be resumed thus:—

Gallitzen or Brush Creek Coal, 2 to 3½ feet thick, as reported near Utahville and as shown on Muddy Run.

Freeport Upper Coal—Bed E—Probably averages from 2′ 9″ to 3 feet thick.

Freeport Lower Coal—Bed D—Probably 3 to 5½ feet thick in country bordering Muddy Run, and from 2 to to 3 feet thick near Glen Hope and Coalport.

Kittanning Upper Coal—Bed C′—No reliable information as to the thickness or this bed—probably thin.

Kittanning Middle Coal—Bed C—2½ to 3½ feet thick along Clearfield creek from Glen Hope to the Cambria county line. Far beneath water level in south-eastern part of township.

Kittanning Lower Coal—Bed B—This is the coal worked at Coalport. It maintains a size of 3 feet as a minimum to 6½ feet as a maximum wherever exposed above water-level.

Brookville Coal—Bed A—From 2½ to 4 feet thick where found above water level along Clearfield creek. It is usually sulphury.

[The following additional facts are extracted from Report H.]

Only one coal is opened in this hill side, and that is the one above the limestone, and is worked by Dr. Caldwell; it yields but 32 inches of coal. The coal is hard, good looking, and breaks out in blocks. The limestone is mainly blue in color, with some grayish layers, and burns well for lime for agricultural purposes.

A specimen of this limestone from Caldwell's quarry, forwarded for analysis, yielded (McCreath):

"Carbonate of lime,	93.810
Carbonate of magnesia,	1.710
Sulphur,	.053
Phosphorus,	.008
Insoluble residue,	2.070

"The limestone is hard, compact, crystalline, and of a bluish gray color."

This limestone can be identified as, in all probability, the Freeport Limestone, and the small overlying coal as the Lower Freeport coal bed.

On the east side of the creek, Mr. J. Cooper has opened up one bed and is working it. The coal is small, not averaging over 30 inches in thickness. It is fairly good looking coal, and answers satisfactorily for local use.

A specimen of the coal forwarded for analysis, yielded (McCreath):

"Water,	0.700
Volatile matter,	24.020
Fixed carbon,	64.951
Sulphur,	1.639
Ash,	8.690
	100.00

"Coke, per cent, 75.28. Color of ash, red.

"The coal has a dull luster, showing much oxide of iron, very hard, with veins of pyrites and charcoal."

The bed of Clearfield creek for some miles above Glen Hope, is made up of massive sandstones, usually grayish.

At the mouth of Witmer run, fire-clay shows in the bed of Clearfield creek.

The iron ore, 60 feet above the creek, at Leightner's, is not opened out fully, but shows three layers of carbonate iron ore of six, three, and four inches respectively, making 13 inches in all. It is reported to have shown as a "3 foot" bed of ore when fully exposed.

A specimen of this carbonate iron ore of J. Leightner's, forwarded for analysis, yielded (McCreath):

Iron,	34.000
Sulphur,	.061
Phosphorus,	.356
Insoluble residue,	18.050

The ore is a carbonate, minutely crystalline, and of a dark gray color, with conchoidal fracture.

The hematite ore in the shales at 240 feet above the creek level, is small in quantity and usually decidedly lean and poor in quality, though occasionally masses of very fair ore are found; and about the same thing may be said of every other crop of hematite ore in shales observed in these Lower productive coal measures during the season's work.

A specimen of the better quality of this hematite ore from the shales, forwarded to Mr. McCreath for analysis, yielded:

Iron,	40.800
Sulphur,	A trace.
Phosphorus,	.596
Insoluble residue,	25.600

The ore is a limonite, hard, compact, silicious, and of a dark brown color.

6. Chest Township.

This lies in the southern tier of townships adjoining Cambria county on the south. It lies west of Beccaria and Jordan townships, and east of Burnside township.

Its topographical and geographical features are strikingly similar to Burnside township. In the latter the main water course, the Susquehanna river, runs near its western boundary in a northerly course. In this township, Chest creek, its principal water course, occupies a precisely similar situation. Both townships have a high dividing ridge running in a northerly course near the eastern boundary, and the head-waters of a number of small runs flowing east, in one case into Chest creek, in the other into Clearfield creek.

At Somerville's mill, on Chest creek, Mr. Somerville has a bank opened on what is probably Bed A, but may be Bed 'A'—the Clarion coal—that shows from two and a half to three feet of coal. It lies only a short distance above the creek—thirty feet, more or less. Mr. Somer-

ville has found six feet of smut on the opposite side of the creek at the elevation at which he expected to strike the bed he has open. This was probably a slip from Bed B, the Kittanning Lower coal.

The upper beds have not been opened in this vicinity. On the east side of Chest creek, near the Cambria county line, the Mahoning Sandstone is found capping the hills as a massive rock. It is here a true conglomerate, some layers being composed entirely of pebbles ranging in size from a large pea down to coarse sand.

The following section of the measures was kindly furnished by Mr. I. A. Harvey, who has recently prospected a tract of 8000 acres lying in Chest and Clearfield townships, in Cambria county, and in Chest township, in this county. It is given as a "Vertical Section along Chest Creek in the Second Basin."

Hill top.	
Lower Barren measures,	50′
Mahoning Sandstone,	40′
Sandy Shales, etc.,	20′
Coal, Bed E, Freeport Upper [Gallitzen],	3′ to 4′
Fire-clay,	3′
Limestone, not opened,	3′ to 4′
Freeport Upper Sandstone [Mahoning],	50′
Shales and Slates,	20′
Coal, Bed D′, Freeport Lower [E],	3′
Fire-clay,	2′
Limestone, not opened,	3′
Freeport Lower Sandstone,	30′
Shales and Slates,	5′
Coal, Kittanning Upper, Bed D [D],	4½′ to 6′
Fire-clay,	2′
Limestone, Johnstown Cement (?),	3′
Shales and Slates,	20′
Coal, Bed C′, not opened, thin,	1′ 6″
Shales and Slates,	20′
Coal, Bed C, Kittanning Middle bed,	2′ 6″ to 3′
Fire-clay,	2′
Sandstone and Shales,	35′
Coal, Bed B, Kittanning Lower, { Coal with thin Slate, 4′ 4″; Fire-clay, 1′ 3″; Coal, 2′ 8″ }	8′ 3″
Fire-clay,	3′
Sandstone,	35′
Shales and Slates,	20′

Coal, Bed A', Clarion,	1' 6" to 2'
Fire-clay,	3'
Sandstone, Sandy Shales, and Slates,	35'
Coal, Bed A', Brookville,	3' to 4'
Fire-clay and Sandstone,	12'
Fire-clay, Blue Ball, etc,	6' to 8'
Homewood Sandstone,	40'
Coal, Mount Savage or Mercer,	1' 6"
Conglomerate (No. XII) to level of Chest Creek,	20'

To bring this section into harmony with the nomenclature adopted in this report, *it is necessary to change the letter D' to E.* The changes this necessitates are indicated by the names inclosed in brackets.

I find that in Clearfield county the occurrence of *an unnamed coal* between the Kittanning Upper and Kittanning Middle (C' and C) beds is very common, and if our coal series were named from a study of the measures in this county, this bed would undoubtedly have been recognized as a persistent member of the series; but in other localities, especially in the western counties, the existence of a coal at this horizon is most unusual.

In the same way we find the Clarion coal (Bed A') in this county more frequently absent than present, whereas it is a well-defined, persistent, and often valuable coal in the western counties.

The coal bank opened at water-level, a short distance above Westover, was doubtless located on Bed A. It corresponds well with the description given by Mr. Harvey.

The T. Westover opening, near the McGarvey settlement, is doubtless on one of the Freeport coals. The bed is reported as being from three to four feet thick. I did not visit this bank.

The Mahoning sandstone is found in the high lands of the McGarvey settlement, and again in the high summits along the ridge road, where the land reaches a height of over 1900 feet above ocean level. This high land in the south-eastern corner of the township marks the location of the First anticlinal axis,—the Laurel Hill axis of Cambria county.

The Nolo sub-anticlinal crosses Chest Creek near Five

Points, but it is here apparently a less prominent flexure than at Marion Cross Roads, in Jordan township.

Very little prospecting has been done in the northern part of the township, and as only a few banks have been opened, the thickness and character of the coals is not well known. From what facts (and rumors) I was able to obtain, I judge the coals are all of quite moderate thickness in this part of the township, and that while the Kittanning Lower Coal—Bed B—may reach a thickness of from five to six feet, it will be found to contain a troublesome slate, bone, or fire-clay parting, and will not maintain this thickness on the lower part of Chest Creek. The Freeport coals may approximate four feet in thickness in some localities, but until more reliable data are obtained it will not be safe to credit either of these beds with more than three feet of coal in the region north and north-east from Westover.

The other beds of the series are not likely to prove valuable, but the Upper Kittanning coal (Bed C') may reach three feet or more in the country adjacent to Jordan township, and will probably furnish coal of good quality. Since writing this report I am informed that this coal has been opened at Westover and found to yield over four feet of clean coal.

Bed A (the Brookville coal), while frequently reported three to four feet thick, will probably be found to average not more than two and a half to three feet. However, it may locally yield three and one half feet of coal, but is usually troubled with sulphur and slate, and is not likely to be of much value in the near future.

The coals seem to exist in better condition in the southern part of the township. Prospecting now being done will probably add largely to our knowledge of this area.

7. Burnside Township.

This lies in the south-western corner of the county, south of Bell and west of Chest townships, and adjacent to Indiana county on the west and Cambria county on the south.

It is drained by the Susquehanna river, which flows in a northerly course near the Indiana county line. The head-waters of streams flowing into Chest creek are found along its eastern boundary.

The upper member of the *Conglomerate* series, No. XII, is apparently above water-level along the Susquehanna river until one approaches Burnside, going up, but it soon passes beneath water-level as we ascend any of its branches.

The *Mahoning Sandstone* is seen in force as a massive conglomerate capping the summits east of the town of Cherry Tree at an elevation of 300 to 350 feet above the river.

Going east towards Somerville's mill, on chest Creek, the summits reach a height of 400 feet above the river, and still show the Mahoning Sandstone as a prominent cap-rock.

Going north towards New Washington we find somewhat higher summits, but the Mahoning Sandstone does not show prominently. It is possible that many of these hills are not quite high enough to catch this rock, but it is more probable that the rock here exists as a soft, shaly sandstone and does not make a well-marked outcrop. East of New Washington it is plainly seen in the high knobs overlooking Chest creek.

The coal opened at New Washington may be the Freeport Lower coal, but its identity with that bed is by no means certain. It is over three feet thick, but contains a bad parting. The Lee & McMichael banks also show coal that can only be mined for local use at present.

There seems to be very little accurate knowledge of the thickness of the coals in this township. As the large bed, opened at Urey's mine in Indiana county, has furnished a supply of coal for the north-western part of the township, the banks opened on the river above Cherry Tree have supplied the south-western part of the township; the banks at New Washington have met the local demand in that vicinity, and banks near Westover have furnished some coal for the eastern part of the township, there has been

little incentive for land owners to develop coals in other localities. Hence, we find an almost entire absence of banks at which the coal may be examined, and very few prospecting openings.

Bed B has been opened by Mr. James Brady in the extreme north western corner of the township, near the Indiana county line. The bed is in all about six feet thick, with a slate parting about one foot thick, and a fire-clay parting of about the same thickness.

The Dowler coal, just opened at the mouth of Cush creek, shows the same partings.

From the character of the Freeport Lower coal, (D,) as described at Westover's mine in Report HH, page 174, we naturally infer that this is not a very valuable bed near Cherry Tree. The measurement is as follows:

"Slate in the roof of bed D.

Coal,	0′ 10″
Slate,	0′ 1½′
Coal,	2′ 3″
Slate,	0′ 2″
Coal,	0′ 8″

Fire-clay in the floor."

35

"Limestone has been taken out from under the fire-clay in the floor. It is compact, semi-crystalline, bluish in color, and sufficiently pure to yield a good lime for agricultural purposes. The thickness of the stratum is unknown." If this is the *Johnstown cement bed*, then the coal must be Bed C′—the Kittanning Upper coal—but this does not seem probable.

A belief is prevalent in many of the localities along the Susquehanna river between Burnside and Clearfield, that thick beds of coal exist at considerable depth beneath the river. This belief is so deeply rooted, that it will never be thoroughly dispelled until the absence of such thick and valuable beds is proven by actual shafting.

The record of the Cherry Tree Gas (oil?) well at Cherry Tree, and of a well said to have been sunk by Dr. Hoyt, are quoted as proof that such beds exist. The former record is given in Report HH, page 179. It shows

2	feet of	coal	at a depth	(from	surface) of	33 feet,
5	"	"	"	"	85	"
5	"	"	"	"	119	"
thin		"	"	"	147	"
5	"	"	"	"	167	"
4½	"	"	"	"	418	"

The borings at Cherry Tree may exaggerate some of the coal beds, but show that all the coal beds sink beneath water-level from Burnside up to Cherry Tree (except perhaps the Freeport Upper Coal) owing to an unusually strong south-west dip towards Cherry Tree. At first sight one would take the massive sand rock 50 feet or more above water-level at Cherry Tree to be No. XII, because the Mahoning sandstone caps the ridge N. E. of Cherry Tree, 300 feet above the river. But the two rocks are the same; the dip down the slope towards Cherry Tree being at least 150 feet per mile.

N. B. The coloring of the geological county map must be corrected, by erasing the color for No. XII along the river from Cush P. O. upward.

8. *Jordan Township.*

This lies south from Ferguson and Knox and north of Beccaria and Chest townships.

Throughout the south-eastern part of the township the coals are elevated by this uplift of the First anticlinal axis, but the prevailing dip is gently to the north-west towards Ansonville. On the road from Glen Hope to Ansonville, the *Mahoning sandstone* is seen near the township line capping the summits at an elevation of about 1780 feet above tide. In the vicinity of Ansonville this rock does not outcrop prominently, but its place is probably about 1575 feet, or a few feet higher than the Ansonville cross-roads, thus showing a dip north-west of about 200 feet.

Going north-west into Ferguson township, we find this rock on Campbell run at an elevation of over 1700 feet. These facts enable us to locate the central line of the Second basin with some degree of accuracy near Ansonville. In the extreme western corner of the township, the Mahoning

sandstone lies at an elevation of about 1825 feet. It is therefore evident that both the north-west and south-east dips towards the center of the basin are well pronounced in this Ansonville district.

Over the central portion of this basin, the highest ground is made by the *Barren measures.*

The Ansonville coal bank has been opened and worked for many years to supply the local demand, and the character of its coal has won it an enviable reputation. At the time of my visit I found the bank mouth closed by a door and fastened with a padlock, but I was able to make a measurement of the bed at the mouth of the drift, where I saw:

Slaty roof of Ansonville coal bed (C').

Coal,	1' 5"
Parting,	1" to 2"
Coal,	1' 5"
Parting, (not persistent?)	1"
Coal,	5"

Fire-clay floor.

The coal is clean, bright, shining, columnar, with an almost inappreciable amount of sulphur, and looks low in ash.

This is the only bank I found open in the township. The same coal was opened on Hiram Straw's place, but is now closed. The coal here lies thirty feet or more below a bed of *limestone* reported from five to six feet thick. Over this limestone, and separated from it by about two feet of fire-clay, there is an eighteen-inch or two-foot bed of coal. This is probably the Freeport Lower coal (D) and limestone, which would make the *Ansonville coal* the equivalent of Bed C'—the Kittanning Upper coal. If this limestone be identified with the Freeport Upper bed, then we must call the Ansonville coal Bed D; but the sections compiled in Knox township do not sustain this view, and the position of this Ansonville coal with reference to the Clarion sandstone is certainly too low to make this identification plausible. I therefore regard this Ansonville bed as the Kittanning Upper coal—Bed C'.

The same bed (?) has been quarried and lime burnt from

it at Mr. T. Rea's place, two miles from Ansonville on the Glen Hope road, and at a somewhat higher elevation than the opening on Straw's place, thus showing a north-west dip towards Ansonville. The limestone was also quarried and burnt at the Straw place, but several years ago both of these enterprises were abandoned.

The beds of Jordan township are therefore:—

Freeport Upper Coal—Bed E. Probably about three feet thick.

Freeport Lower Coal—Bed D. Probably two to three feet thick.

Kittanning Upper Coal—Bed C'. Furnishes an excellent coal, and will probably average from three to three and a half feet in thickness.

Kittanning Middle Coal—Bed C. Reported thin.

Kittanning Lower Coal—Bed B. Frequently reported as three and a half to four feet or more thick. Will probably be found to average not much over three and a half feet of workable coal.

9. Ferguson Township.

This lies south of Penn and Glenwood townships, west of Pike, Knox, and Jordan, and north-east of Chest township.

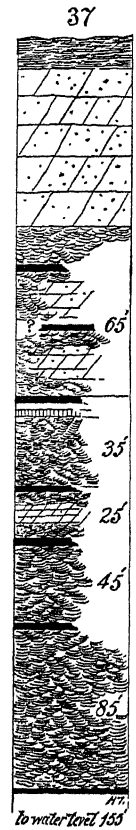
It lies entirely in the Second Basin, and nearly all of the high dividing ridges are capped by the Mahoning Sandstone, and therefore contain all the beds of the Lower Productive coal measures; but, as very few openings have been made, it is almost impossible to learn the thickness of any of the beds.

The *Mahoning sandstone* is seen in force in the hills near Marion Cross-roads, where it lies from 1775 to 1825 feet above tide. Its elevated position is due to the presence of a subordinate anticlinal axis which crosses in this vicinity. It dips rapidly to the south-east towards Ansonville, and probably falls gently to the north towards Bellville, where it lies more than one hundred feet lower.

Going down the hill from the summit of the divide at Moore's place to Lumber City, a number of coal smuts may be seen. In the following section the intervals cannot be considered absolutely correct because no allowance has been made for dip.

Section at Lumber City.

Soft shales, Mahoning sandstone, Soft shales, in hill-top,	100′
Coal Smut, Bed E.	
Shale and shaly sandstone, (Bed D not seen,)	65′
Coal smut, Bed C′ (D.)	
Fire-clay, about	3′
Limestone, Johnstown Cement bed, about	2′
Shales, some sandy shale,	35′
Coal smut, Bed C (C′.)	
Shales with 15′ of flaggy, argillaceous sandstone,	25′
Coal smut, Bed B (C.)	
Soft shales,	45′
Coal smut, Bed A (B.)	
Soft shales,	85′
Coal bank, (now fallen shut,) (A,) about	2½
Sandy and shaly measures to river level,	155′



The lowest coal is doubtless an Intra-conglomerate bed, and the Clarion sandstone and upper member of the conglomerate are represented by soft shaly measures, but as another construction is possible, I have indicated it by the letters inclosed in parentheses. However, the limestone of the section appears to be the Johnstown cement bed, and not the Freeport Lower lime. It lies 340 feet above the Lumber City bridge over the Susquehanna.

The beds of Ferguson township are therefore:—

Freeport Upper Coal—Bed E. This coal is probably not more than three feet thick in this township.

Freeport Lower Coal—Bed D. I saw no opening on this bed. It is probably two to three feet thick.

Kittanning Upper Coal—Bed C.′ The smut of this coal indicates a thin bed, but may have a local thickness of nearly four feet.

Kittanning Middle Coal—Bed C. This is reported as being about two and one half feet thick, but may reach three feet in some localities.

Kittanning Lower Coal—Bed B. Probably two and one half to four feet thick.

Brookville Coal—Bed A. About two and one half to three feet thick.

10. Knox Township.

This lies north of Jordan and Beccaria townships, and between Clearfield creek on the east and Little Clearfield creek on the north-west.

Along the line of Little Clearfield creek the Clarion sandstone is generally one hundred feet above water-level, but the Conglomerate measures do not show prominently in the banks of the creek. Some of the massive layers of the Conglomerate are here evidently replaced by soft shaly sandstones and shales.

Near Cathcart's mill the fire-clay bed lies some fifty feet above water-level, and at New Millport it is found at nearly the same place.

Going south-east from the creek the rocks rise rapidly towards the first axis.

The *Mahoning Sandstone* is seen along the ridge road running towards the "Barrens," near the Mount Pleasant school house, and at an elevation of about 1650 feet, by barometer, above tide, or 450 feet above stream-level. This would place the top of the Clarion Sandstone 200 feet above the stream; but as we go north-west towards the stream the dip carries this rock down to about 100 feet above stream-level.

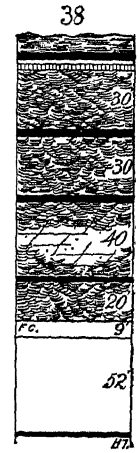
About one mile and a half below Mitchell's saw-mill a bed of coal four feet thick is commonly reported as outcropping near stream-level. It is also stated that two feet of slate or fire-clay occur under the coal, beneath which there is about two feet of coal. This is probably Bed A, but may be an Intra-conglomerate coal.

The line of greatest elevation of the First Anticlinal axis passes through the south-eastern part of the township, lifting the top of the Conglomerate No. XII about 240 feet above Clearfield creek in the hills near the mouth of Lost run. The prevailing dip is north of west towards the central line of the Second Basin, but local dips to the south-east are occasionally observed. The north-west dip is very strong in the vicinity of the head-waters of Potts run. Some of the high land between Potts and Lost runs takes in all the productive measures, but the area underlaid by the Freeport beds is comparatively small. Limestone occurs near the Cove Run school-house, and a bed of coal five feet thick is reported on the Irvin estate on Lost run. It is probably one of the lower beds.

At Reuben Caldwell's place the following section was compiled:

38

Coal (D?) in hill top, only a few feet of cover,	"say" 2′
Fire-clay,	"say" 2′
Limestone, (Freeport Lower?,)	"say" 2′
Interval, about	30′
Coal, (Bed C′?),	3′ 8″
Fire-clay, Interval, about	30′
Coal, (C?),	3′
Fire-clay, Interval,	40′
Coal in well, (B?),	2′ 6″
Fire-clay, Interval,	20′
Fire-clay,	9′
Interval,	52′
Coal? Bench, springs, (Bed A?),	



Top of Conglomerate No. XII about 50 feet above level of Potts Run.

The coal noted above as probably the Kittanning Upper bed (C′) has been opened and is reported as showing.

39.

Slaty roof.	
Coal,	3′ 4″
Fire-clay,	2″
Coal,	2″
Fire-clay floor.	

Mr. Caldwell has also opened the next bed below, which shows

Slate roof.	
Coal, about	1′ 6″
Slate and coal, (mixed),	1′ 6″
Fire-clay floor.	

Bowlders of the limestone—which I consider the Freeport Lower limestone—are frequently plowed up in the field above Mr. Caldwell's house.

The elevation of the different coals in this locality may be easily calculated from that of the Kittanning Middle coal—Bed C—which lies about 1595 above tide.

In the western part of the township the measures seem to have a dip towards the south-east.

The beds of Knox township are:—

Freeport Upper Coal—Bed E. No trustworthy information. Probably three feet, or less, thick.

Freeport Lower Coal—Bed D. Probably from 2 to 3 feet thick.

Kittanning Upper Coal—Bed C′. May have a local thickness of four feet, but will average little over three feet.

Kittanning Middle Coal—Bed C. Probably ranges from 2 to 3 feet.

Kittanning Lower Coal—Bed B. This coal will probably range from 2 to 3 feet, but may reach four feet or more over small areas.

Brookville Coal—Bed A. This is probably not more than 2 or 2½ feet thick.

11. Boggs Township.

This lies west of Morris, north of Decatur and Woodward townships, and south of Bradford township.

The prevailing dip throughout the central part of the township is to the west and north-west.

First Anticlinal Axis. Two miles west from Blue Ball Station the fire-clay overlying the Conglomerate No. XII is extensively worked. It lies at elevations varying from 1830 to 2050 feet above tide. At Blue Ball the top of the conglomerate is not more than 1580, and at Wallacetown about 1720 feet above tide. The axis crosses the railroad near Wallacetown. From this point to the highest point, (crest,) No. XII, at the fire-clay workings, the course is about S. 60° W. It is, therefore, evident that this axis is not a straight line.

Going out of Wallacetown along the road to Stoneville, we find the Conglomerate rising rapidly, so that at a distance of one mile from the station it is found at 1800 feet above tide.

This area, lying between and west of Wallacetown and Blue Ball, can hardly be considered as an anticlinal axis. The elevations of the top of No. XII plainly show that this rock is here elevated in the form of an irregular *dome*. If we trace out the highest points along this elevated area, and consider them as representing the line of the axis, we obtain the irregularly-curved line shown on the county map.

Along the road between Wallacetown and Stoneville we find several summits high enough to catch the Freeport coals, and one hill in which the Mahoning sandstone undoubtedly occurs.

Several coal banks are opened in this vicinity on the Kittanning coal beds. Most of them appear to be located on the Kittanning Middle coal—Bed C. None of them show coal of good thickness. They commonly range from two feet and eight or nine inches to three feet and two or three inches.

Mr. S. Lambert has a coal 3′ 3″ thick opened in the hill between Clearfield and Little Clearfield creeks. It is a good bright coal, free from sulphur, but contains a thin parting of slate. Mr. Lambert uses it in his blacksmith-shop, and finds it an admirable coal for this purpose.

A thin Intra-conglomerate coal was opened some years ago a short distance above Mr. Lambert's place.

The valleys of Clearfield and Little Clearfield creeks are sharp, narrow gorges eroded in the hard rocks forming the Conglomerate series No. XII. The high land back from these streams commonly contains about 200 feet of coal measures, and the higher knobs probably take in the Mahoning sandstone.

The following facts are extracted from Report H.

"Passing west and north-west along the Tyrone and Clearfield railroad from Blue Ball Station, the point where the First anticlinal axis crosses the railroad, about ½ mile beyond the station, is marked by a beautiful exhibition of the seral conglomerate or millstone grit. Enormous bowlders of fine-grained white quartzose sandstone, with some brownish massive sandstone, are found, and occasional massive layers of conglomerate rock with rounded white quartz pebbles of the size of a pea and larger. The mass rises as a wall 50 to 60 feet high. Some of the loose blocks will contain over 2000 cubic feet. As exposed here, this mass of sandstone and conglomerate should be in all some 200 or more feet in thickness.

The railroad, following the stream, keeps in this conglomerate, sometimes dipping softly in one direction and then back again, or about flat until near Wallacetown, where overlying measures come in, and coal is found outcropping. In wells in the village a small coal is struck only a few feet below the surface, with from 6 to 12 feet of fire-clay underlying it. Where the lowest exposed coal was struck in a well, about 500 yards south-west of Wallacetown, it shows about 2 to 2½ feet of coal with fire-clay floor and sandy gray slates for cover. Jacob Smael's mine had fallen shut, but the props of the main entry were only 2 feet 9 inches high, and the bed of course must have been small. The dip, at this point, is slightly back to the south-east.

At Shimmel's opening, two thirds of a mile north-east of the station, the main entry has fallen in; but from the size of the opening the bed could not have been large. Gray slates overlie the bed. On the hill south of this mine, two

small beds were once opened up, dipping to the south-east gently.

At Ross Summit, half a mile north of Wallaceton, a railroad cut shows:

Top of cut.		
Thin-bedded sandstone,	8′	
Sandstone,	1	
Impure fire-clay,	4	
Black slate,	3	6″
Coal,	0	6
Fire-clay in bottom,	4	

This cut shows the unevenness of the measures in this neighborhood; the summit being a small synclinal, the rocks on either side dipping gently into the center of the cut.

Thence westwardly to Clearfield town, about the same measures are exposed.

A few miles farther up Clearfield Creek, about one mile above where Little Clearfield Creek comes in, on Lambert's place, is an exposure of a very peculiar ore deposit. The lower massive sandstones of the Productive Coal Measures, which have before been in the bed of the creek are here carried well up into the hills in obedience to the first anticlinal axis. This axis has been already described as the northern extension of the Great Laurel Hill axis. At Lambert's massive sandstones, but without conglomerate layers so far as seen, make the sides of the creek for 100 to 125 feet above the water. Two hundred feet above the creek-level the surface of the ground is covered for some acres with a peculiar, rough-looking iron ore, in lumps of all sizes, some of the pieces making from 150 to 200 pounds. In the midst of this outcrop, which fades away both on the ends and sides, but continues longest and most decided down the face of the hill, a shaft has been put down, which shows thus:

Outcrop lumps on surface.	
Loose sandstone pieces with some few ore lumps,	5′
Ferruginous sandstone with lean ore,	5
Red, clayey ore,	1′ to 2
Clay slate, ferruginous, with some red ore,	6
White sandstone in bottom.	

A specimen of the best quality of the outcrop surface ore yielded on analysis (McCreath):

Iron,	42.400
Sulphur,	.039
Phosporus,	.082
Insoluble residue,	23.120

The above analysis represents an iron ore of very good quality, but the great mass of the ore deposit was leaner and more sandy.

The ore analyzed was a limonite, compact, with laminated structure and reddish brown color.

Thirty feet above this iron ore there is the smut of a small coal, the lowest coal bed showing in these measures.

About 400 yards up a small run which enters Clearfield Creek at this point, a bog ore is found extending apparently over some acres. As the stream bed here is at the bottom of the seral conglomerate, the bog ore may represent iron brought from the carbonate iron ore of XI, just below the conglomerate of XII. The ore deposit seemed to extend over an area of about one hundred yards in length along the valley, by about fifty yards in breadth. The depth was not found, but apparently it was not great."

12. Bradford Township.

This lies west of Graham and north of Boggs township, and its northern and western boundary is formed by the West Branch of the Susquehanna river, separating it from Girard and Goshen townships.

It lies wholly within the Second Basin, the central line of which crosses it from north-east to south-west.

The First anticlinal axis at Wallacetown is only a short distance from the south line of the township.

Under normal conditions the prevailing dip from this axis towards the center of the basin would be to the north-

west, but the anticlinal is rapidly subsiding at Wallacetown and we consequently find the prevailing dip is more to the north than north-west.

At Wallacetown the top of No. XII, the Conglomerate, is about 1720 feet above tide, but at Woodland we find it at about 1450 feet or lower, showing a fall north-west of 270 feet.

This rapid dip towards the center of the Second Basin is plainly shown by some of the railroad cuts between Wallacetown and Woodland. In one cutting a thin bed of coal is exposed for some distance which shows a remarkably sharp dip to the north.

The lower portion of the coal measure occupies most of the surface of the township, and only a smaller portion is sufficiently high to take in the upper beds of the series.

The Second Basin is not as deep in this township as at points further north-east, for the Rock City, near Kephart's, plainly shows the Mahoning S. S. at an elevation of about 1760 feet above tide, while to the north-east, in Girard township, this rock occurs in the center of the basin at (top) 1550 feet above tide.

It is therefore evident that the Second Basin is sinking as we go north-east towards Karthaus.

The top of the Conglomerate, No. XII, is above water-level on all the creeks and runs in the northern and western parts of the township.

The Fire-clay workings in the vicinity of Woodland are principally confined to the south side of the railroad, probably because the dip being to the north, workings on the north side of the run are difficult to drain.

As a special chapter is devoted to the fire-clay industry, no further mention of it is here necessary.

The coal beds opened in this township are all of rather small size. Most of the country banks are opened on Bed B or Bed C, neither of which much exceeds three feet in thickness.

In the eastern part of the township Mr. J. G. Gray has two openings on what appears to be the Kittanning Upper

coal (Bed C'), but which may be Bed B, at which the coal is reported thus:

Coal,	2′ 8″ to 3′ 10″
Clay Slate,	3″ to 10″
Coal,	1′ 2″ to 1′ 4′

The dip is here north-west, thirty feet in a distance of less than half a mile. The bed is opened at an elevation of 1730 feet above tide.

In the northern part of the township Mr. D. Kephart has opened a coal bank on a branch of Millstone Run at an elevation of 1435 feet above tide. It is difficult to exactly place this bed in the series, but it is probably either Bed A or an Intra-conglomerate coal.

The W. Woodbridge bank, near the center of the township, shows 3′ 10″ to 4′ 0″ of coal, but the uppermost ten or twelve inches is very bony and sulphurous. Only the lower three feet of this coal should be worked, and I doubt whether it will furnish a marketable fuel.

This bank seems to be opened on the Freeport Lower coal, Bed D. The coal is underlaid by fire-clay and some slate, beneath which a band of iron ore is found which possibly here represents or replaces the Freeport Lower Limestone.

Three miles south-west from Wooldridge's, and one mile and a half north-west from Woodland, Mr. B. Lansbury has opened a bank on what appears to be the Kittanning Middle coal—Bed C—at an elevation of about 1580 feet above tide. The bed yields scant three feet of coal.

The Mahoning sandstone here caps the highest hills. This rock is also seen at other points going north-westwardly. Near Mr. D. Kephart's place, south from Half Moon Bend, it makes a grand show on the side of a hill, and where seen in place at the summit of the hill, it forms a *Rock City*.

The smut of a coal bed is seen in the road near Mr. B. Stewart's place, near the center of the township. It is probably the Freeport Lower coal.

Passing down from Stewart's towards Mr. S. P. Wilson's place, on Millstone run, we soon see the Conglomerate, which continues above water-level from this point down to the mouth of the run.

The old "Lansbury bank" is apparently opened on the Kittanning upper coal—Bed C'. It shows three feet of clean coal of excellent quality.

The beds of Bradford township are:—

Freeport Upper Coal—Bed E—No reliable information. This bed is probably quite thin.

Freeport Lower Coal—Bed D—From three to four feet thick. Has not yet been found in good condition.

Kittanning Upper Coal—Bed C'—Probably averages about three feet, and yields coal of good quality.

Kittanning Middle Coal—Bed C—From 2 to 3 feet thick, averaging from 2 to 2½ feet.

Kittanning Lower Coal—Bed B—Frequently reported four or five feet thick.

Brookville Coal—Bed A—This is probably from 2½ to 3½ feet thick.

13. Graham Township.

This lies north and west of Morris township and east of Bradford township. The West Branch of the Susquehanna River forms its northern boundary line, separating it from Covington and Girard townships.

It lies almost entirely in the Second Basin, and upon the south side of that basin. The prevailing dip of the coal rocks is, therefore, north and north-west towards the axis of the basin which crosses the northern part of the township near Deer Creek bridge.

A large percentage of the surface is occupied by coal measures, but only a very limited area is sufficiently high to take in the upper and more valuable Freeport coals—Beds D and E.

The Conglomerate measures, No. XII, are above water-level along all the principal creeks and runs. The whole series is above water-level in the Susquehanna, and the top of the Mauch Chunk red shale is also above water-level.

Along the hills overlooking the river the outcropping Conglomerate rocks—through which the river has eroded its channel—make steep bluffs, but not cliffs, 350 to 400 feet high.

Some of the Conglomerate beds show very large pebbles. I have obtained a few fully as large as a hen's egg, but it is unusual to find them larger than a hazelnut or small walnut. The coarse pebbles seem to occur in a stratum near the base of the series.

Coal has been found below the top of the Conglomerate (Intra-conglomerate beds) but I could not learn that any valuable bed had yet been opened.

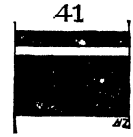
The first *anticlinal axis* apparently runs from Wallacetown north of east, just crossing or touching the south-east corner of the township. It is evidently declining rapidly, for at Wallacetown the Conglomerate is, say, 1720 feet above tide. At the junction of the Deer Creek and Morrisdale roads it is (beneath the surface) about 1645 feet above tide, and near Kylertown it is not more than 1490 feet above tide, here also lying beneath the surface. These points seem to lie nearly on the crest of the axis, or so much of the crest as is left in this vicinity.

Coal B ? is opened in the south-western corner of Graham township at Mr. P. Kepple's place, near the township line, and one half mile west of Kylertown, at an elevation of about 1550 feet above tide. This is doubtless the bank reported as "Keffer's mine" in Report H, of which the following measurement is given. The bank is now fallen shut:

Black slate roof, good.

B? { Coal, ... 9″
Slate, ... 4″ to 6″
Coal, ... 3′ 3″

Fire-clay floor.



This bank is probably opened on Bed B, but its identity with that bed is not absolutely proven. It may possibly be a higher bed. One mile and a half north-west from this bank, we find the Conglomerate, No. XII, above water-level at Schoonover's mill, at an elevation of about 1425 feet above tide. If Kepple's bank is opened on Bed D, then

we have here a *rise* to the N. W. of 55 feet; if opened on B, there is a *dip* to the N. W. of about 85 feet. Going north towards the Deer creek bridge over the West Branch, we find the top of the Conglomerate, No. XII, near Lansbury's place, at about 1360 feet above tide, showing a fall towards the center of the Second basin of 65 feet. This plainly shows how rapidly the First axis declines to the N. E. from Wallacetown, where No. XII is seen at an elevation of over 1700 feet.

The Mahoning Sandstone is seen capping the hills on the road leading south from the Deer creek bridge, at elevations of 1610 to 1660 feet above tide. It apparently dips northwardly (50 feet) towards the line of the Second basin. Some of the lower coals have been opened along the river hills in the northern part of the township, and are reported as ranging from two feet and ten inches to three feet and two or three inches thick.

Coal C'?.—A short distance east from Centre Hill two banks have been opened in close proximity on what appears to be the Kittanning Upper coal, which is commonly known as the "slate vein," or "dirty vein." This may, however, prove to be Bed B. Both of these openings had fallen shut and were inaccessible when visited.

Mr. J. Holt, who owns one of these banks, gives the coal measurement as follows:

Slate roof.

C'?	Coal (good),	2' 2"
	Slate,	6" to 1' 10"
	Coal (poor, sulphury),	1' 6"
	Slate,	0" to 5"
	Coal,	1' 6"

Fire-clay floor.

42.

The coal here shows a strong westward dip. Its outcrop is seen on the road three fourths of a mile west from the openings, at an elevation of about 1675 feet above tide, while at the banks it lies about 1725 feet above tide.

The Mahoning Sandstone apparently caps the highest summits, but the hills are not high enough to catch its full thickness.

The Conglomerate, No. XII, is above water-level along

Moravian Run and its branches from near the head-waters down to the mouth of the stream. From Centre Hill down to Grahamton the measures dip almost as fast as the stream falls, so that this rock is very little higher above stream-level at the mills than where seen one mile from Center Hill.

Its elevation at Grahamton is about 1525 feet, more or less, above tide, or about one hundred feet higher than at Schoonover's mill on Alder Run.

In the north-eastern part of the townships the measures lie rather flat, but with a general and rather gentle dip north or north-west towards the river.

The summits are not high enough to catch the Freeport coals (D and E), but some of the highest knobs may catch the Kittanning Middle or Upper coal. Although the general dip is towards the river, some local south and south-east dips were observed.

The central line of elevation of the *first anticlinal axis* crosses the south-eastern part of the township a short distance from Kylertown, but it is not well defined and its exact location is not easily determined.

Hubler bank.—At Amos Hubler's place a coal opening apparently occupies the horizon of the Kittanning Middle coal, but a more thorough development of the measures in this neighborhood may show it to be either the next bed above or below. The bank was flooded and could not be entered at the time of my visit. The coal is thus reported:

Slate roof.
Coal, (about,) . . . . . 3 0″
Slate, ... 6″ to 8″
Coal, (about,) . . . . . 2′ 0″
Fire-clay floor.

43.

This structure is so similar to that of Bed B that I am somewhat inclined to so identify it. The coal contains some sulphur balls which can be separated with little trouble.

Forty feet below this coal a four-foot bed is reported as having been opened, and forty-five feet below this a three-

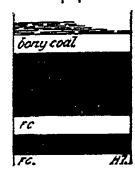
foot bed is said to have been found in prospecting shafts. The dip is north, towards the river.

In Report H, a measurement of the *Hubler bank* is given, which is doubtless much more reliable than the above. It shows the characteristic structure of Bed B throughout this part of the county.

"Slate roof.

B.	Bony coal,	1′
	Coal,	3′ 3′
	Light colored shaly parting, (fire-clay shale?)	1′
	Coal,	1′
Fire-clay floor, (seen,)		0′ 9″

44



And an analysis made by McCreath is given thus:

"Water at 225,	0.420
Volatile matter,	25.510
Fixed carbon,	67.221
Sulphur,	2.479
Ash,	4.870
	100.000

"Coke, per cent, 74.570. Color of ash, pink."

[The following additional facts are extracted from Report H.]

One mile south of where Alder run crosses the Grahamton and Kylertown road, a drift has been put in on a coal outcrop. The coal shows the following section:

Roof, bluish slate.	
Coal smut and bone,	0′ 6″
Coal,	2 6
Shaly parting,	0 6
Coal,	1
Fire-clay floor.	

This gives 3½ feet of coal; a good workable bed. Near the mouth of the drift, on the north side, there is a hard micaceous sandstone cutting out some of the coal; thus showing some of that irregularity which is so frequently found in working coal beds A and B.

The third opening is made on the A. Hubler place, in Graham township, not far from the previous trial pits. This *Hubler mine* is worked in a small way for local use, yielding from 1,000 to 2,000 bushels a year.

The coal measured as follows:

Slate roof.	
Bony coal,	1′
Coal,	3 3″
Light colored shaly parting,	1
Coal,	1
Fire-clay floor,	0 9

The coal mines out bright and clean.

An average sample forwarded for analysis, yielded (McCreath):

Water at 225°,	0.420
Volatile matter,	25.010
Fixed carbon,	67.221
Sulphur,	2.479
Ash,	4.870
	100.000

Coke, per cent, 74.570. Color of ash, pink.

A section made at this place gives the following series:

Hill top.	
Concealed measures,	30′
Coal, Hubler,	4 3″
Micaceous sandstone and *concealed measures,*	39
Slate,	11
Coal, not seen, called	4
Concealed measures,	20
Coal, not seen.	

The beds of Graham township are therefore—

Freeport Upper Coal—Bed E. No banks; reported thin.

Freeport Lower Coal—Bed D. I found no banks opened on this bed. It is reported as being thin.

Kittanning Upper Coal—Bed C′. Locally six (?) feet thick, but with bad slaty partings.

Kittanning Middle Coal—Bed C. Will probably be found to range from two to three feet thick.

Kittanning Lower Coal—Bed B. This varies from three to six feet thick. When over 3½ feet thick it usually carries a bad parting of fire-clay shale.

Brookville Coal—Bed A. Commonly 2½ to 3 feet. Reported locally four feet thick.

14. Bell Township.

This is a large township lying adjacent to Indiana and Jefferson couties on the west, south of Brady and north of Burnside township.

In the northern part of the township the land is very high, the crest of the divide between the waters of the Susquehanna River and Mahoning Creek often reaching a height (by barometer) of more than 2200 feet above tide. This high land marks the uplift of the *Second* or Chestnut Ridge *anticlinal axis*. It is capped by the Mahoning Sandstone.

From this ridge southwardly and south-eastwardly towards the river we find the measures dipping rapidly, so that while the place of Bed B at Mitchell's Camp is about three hundred and fifty feet above the river near McGee's, we find the same horizon at the latter place at an elevation of less than two hundred feet above the river.

This high country north of the river is but sparsely settled, by far the greater part being timber land, but along the ridge road running from the Irish settlement to Punxsutawney, and north of this road, many farms have been cleared up.

In the country drained by streams flowing west and north-west to the Mahoning, the dip is probably west or north-west towards the center of the Third Basin.

South of the high divide the country falls off rapidly as we approach the river, so that while the Mahoning Sandstone covers a large area on the divide, the hills to the south are rarely high enough to hold large areas of Bed D with sufficient cover to insure hard coal.

Very few openings have been made in the northern part of the township. At some old openings made eight or ten years ago on the road to Big Run, near the Jefferson county line, the beds were reported as being from three to three and a half feet thick. These banks were probably located on Beds D and E.

In the area south of Bear Run and west of the Susquehanna River the hills are not high enough to take in an appreciable area of Bed D.

A bed of coal has been opened near McGee's at several places at an elevation that makes its identification with Bed B almost certain. It is reported as showing a thickness of four feet, but other (prospecting) openings made in the same neighborhood report only three feet and a half, while at some diggings to the south-west about six feet of smut have been found at this horizon. We may therefore conclude that this bed will be found rather variable in thickness, and in the absence of more definite knowledge we may consider its average thickness at about four feet.

The coal exposed at water-level at "Coal Bank Bend" is a thin Intra-conglomerate bed.

Bed A has been opened at a few country banks. It shows from two to three feet of coal.

A short distance below Mahaffy's the rocks of the Conglomerate Series, No. XII, are finely exposed along the river road, where a massive sandstone may be seen dipping strongly to the east or north-east; but this dip appears to be local, for as we go down the river we soon find the rocks dipping in a contrary direction.

At this exposure the irregularity of these measures is finely shown. The sandstone at one place in a distance of a few feet almost entirely disappears and is replaced by an irregular mass of shale and fire-clay with a thin seam of coal.

For three or four miles below Mahaffy's the river runs at intervals directly over massive sandstones of No. XII, but as these are rising rapidly we soon see them cropping out boldly on both sides of the river.

In the south-western corner of the township Mr. Baird opened a bank on what appears to be Bed C, the Kittanning Middle Coal. The bank is now shut. Mr. Baird reports the coal as showing:

Coal, (good,)	1′ 3″
Slaty coal,	2′ 8″
Fire-clay floor.	

In the area lying on both sides of Chest creek south of the river, very few openings have been made, and while most of this area has been thickly settled for many years,

the residents apparently do not know much about the thickness or character of the coals.

Coal has been opened near Mahaffy's mill on Chest creek and is reported as being three or four feet thick. I did not visit this opening, but from its location I judge it is opened on Bed B.

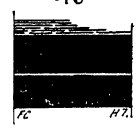
The top of the Conglomerate, No. XII, continues above water-level along the Susquehanna river and on Chest creek, but it nowhere exhibits a well marked conglomeratic character.

[The following additional facts are extracted from Report H.]

At Weaver's place, at the north end of Bell township, a small ten to twelve inch coal, lying upon a fire-clay floor, is opened just above water-level. Some 50 feet above this, a ten inch coal was opened, and a small bench shows about 50 feet above this latter, but has never been opened up. Pieces of a bastard, sandy limestone are found in the stream wash. One third of a mile south-west of Weaver's, in Bell township, Mongold's coal mine is opened and worked. It shows (Fig. 45):

Roof-clay slate, running into black slate,	6′	
Bony coal and slate,	0′	½″
Coal,	1′	11½
Black slate, persistent,		½
Coal,	1	7
Fire-clay floor, hard.		

45



The coal mines out hard and bright. An average specimen yields on analysis (McCreath):

"Water,	0.860
Volatile matter,	31.600
Fixed carbon,	61.662
Sulphur,	2.228
Ash,	3.590
	100 000

Coke, per cent, 67.54. Color of Ash, brown with red specks.

The coal is bright, with shining luster, rather compact, shows little pyrites."

The coal dips decidedly to the north-west.

This coal mine is high up on the Second Anticlinal axis, which probably has its center not more than from one half mile to one mile south-east of the opening.

The beds of Bell township are—

Freeport Upper Coal, (E.) No reliable data. Probably 3 to 4 feet.

Freeport Lower Coal, (D.) No reliable data. Reported 3½ to 4 feet.

Kittanning Upper Coal, (C'.) No opening on this bed.

Kittanning Middle Coal, (C.) 3 to 4 feet thick. Lower half slaty.

Kittanning Lower Coal, (B.) 3 to 6 feet thick; fairly good coal, sometimes sulphury; commonly contains bad fire-clay and slate partings.

Brookville Coal, (A.) 2 to 3 feet thick; generally sulphurous.

15. Greenwood Township.

This is one of the smallest townships in the county. It lies south and west of Penn, north and west of Ferguson, and east of Bell townships.

All of the higher summits catch the *Mahoning Sandstone*, and therefore contain all the coals of the Lower Productive measures; but the beds have as yet been opened at only a few places, and it is difficult to judge the value of the land as coal territory.

The northern part of the township is now being thoroughly prospected, most of the coal having been bought by Mr. Irvin, in connection with large purchases in Penn township.

In the northern part of the township the measures dip to the south-east, but in the southern part of the township the rocks show a decided dip towards the river. This north or north-west dip is occasioned by the Nolo Anticlinal sub-

axis which here divides the Second Basin into two sub-basins.

The base of the Mahoning Sandstone near the blacksmith shop near Mr. George Ross' house, is about 1600 feet above tide, while to the south-east, near Marion Cross-roads, in Ferguson township, the top of this rock is over 1800 feet above tide, and in Penn township this rock lies from 1650 to over 1800 feet above tide, thus plainly showing the existence of a sub-basin with its center crossing near Bellville.

One of the Kittanning coals has lately been opened on the John A. Rowles place, but the bed is only 2′ 8″ to 3′ 0″ thick. This bank appears to be opened on Bed B, but may be located on a higher bed.

A "*four-foot vein*" is reported as having been opened on the Thompson place, three miles above Bellville. I did not visit this opening, but from its location I judge it is on one of the lower beds, probably Bed B.*

Dr. J. P. Hoyt states that he has found three beds of limestone in the hills south of the river; that the middle bed is the thickest and gives a white lime. These are the Freeport Upper and Lower limestones and the Johnstown cement bed, and this is the only locality at which I have found the presence of all three beds known or even suspected. Dr. Holt has also opened all of the coals, mostly by small prospecting holes, but all of these openings are now closed. He states that the upper beds are all thin, barely reaching three feet, but that one of the lower beds (probably Bed B) is quite thick. In the absence of openings that may be examined the thickness and character of the coals in this township must be judged from openings in the adjoining townships.

At Lewisville the Johnstown cement (limestone) bed was burnt some years ago, but as it was found to be very impure the enterprise was abandoned and the kiln torn down. The bed lies about two hundred feet above the river.

The *Kittanning Upper Coal*—Bed C′—lies only two to

* I have since visited this opening and find less than four feet of rather poor, dirty coal. It seems to be bed A.

four feet above the limestone; it is quite thin, probably not more than two feet thick.

The *Kittanning Middle Coal*—Bed C—is also thin in this locality.

The *Kittanning Lower Coal*—Bed B—is reported from three to four feet thick, but is not worked. It lies 80 to 100 feet above the river. Bed A, the Brookville coal, should, therefore, lie from thirty to fifty feet above water level. This is doubtless the bed that was dug into some years ago a short distance above the river on the road from Lewisville to Bellville.

I could obtain no trustworthy information as to the thickness of the Freeport coals, (D and E,) in this neighborhood —they are probably of very moderate size.

16. Penn Township.

This lies west of Pike, south of Bloom and Brady townships, and east of Bell township.

It contains some very high land, especially in the northern and western part of the township, where the summits rise to a height of 2000 feet above tide.

Large areas, in fact nearly all the high land, contain the *Mahoning Sandstone*, with some *Barren Measures* capping the higher knobs.

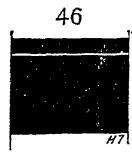
The prevailing dip appears to be nearly uniformly to the south-east, but in the area east and south of Little Anderson Creek the rocks exhibit a nearly west dip. This is caused by the anticlinal sub-axis, which apparently rises near Lumber City, and divides the Second Basin into two sub-basins; Penn township lying in the north-western sub-basin.

Bed C?—At least one valuable bed of coal, four to six feet thick, has been found to underlie a large area in this township. It appears to be the Kittanning Upper Coal but may prove to be the Freeport Lower Coal—Bed D. Its developed area, as a thick and valuable bed, lies west of Pennville and Little Anderson Creek. The following

measurements will plainly show the value of this coal territory.

At the Davis opening, on the Jos. Davis place, one mile north-west from Pennville, I measured bed D where it showed:

Coal,	10	
Bony parting,	1″	
Coal,	4′	1″



Mr. Davis states that over the coal worked there are two inches of slate, overlaid by one foot of coal, and that the floor of the bank is a four inch slate seam underlaid by three inches of coal, which would make the following measurement:

Sandstone roof, sometimes slate roof.

Coal,	1′		
Slate,		2″	
Coal,	10″		
Bony parting,*		1″	
Coal,	4′	1″	
Slate,		4″	
Coal,	3″		
Total coal,	6′	2″	Refuse, 7′

The coal at this bank shows very little sulphur, is bright, shining, and columnar, resembling the Houtzdale coal.

Mr. Davis once found a two foot bed of coal in prospecting for limestone in the hill above the bank. This was probably the Freeport Upper (Lower?) coal.

Fragments of the *Mahoning sandstone* are seen on the surface near the Catholic church, and in the high hill three quarters of a mile north from the Davis bank, this rock is apparently in place with its top about 1815 feet above tide. The elevation of the Davis opening is about 1675 feet. On the west side of this hill an old bank was once opened near the house on the old Richard Denver place. This bank is at an elevation of about 1721 feet, and is therefore rightly located for Bed D, and is probably the same with the Davis bed. The coal is reported as being rather thin.

A short distance north-west from this old bank, Mr. Nelson Walker has cut a coal in his well, which he reports as

*Not considered as refuse, but sold with the coal.

being four feet thick, at a depth of twelve feet. This would make it exactly level with the Denver old opening.

Miller's bank is located about one quarter of a mile east from the Davis opening, and is probably on the same bed, but it shows a somewhat different structure. While there is here about five and one half feet of coal, the bed contains a parting two or three inches thick, about three feet from the bottom, which Mr. Davis thinks is shown in his bank by a streak of "bony looking" coal at about the same place in the bed. I think, however, that this parting is simply the second parting seen in the Davis bank, but that it has thickened up and occupies a somewhat lower place in the bed.

Hartshorn's bank is about one mile and a quarter south by west from the Davis opening. The coal varies from a little less than four feet to five feet, showing in two benches, the upper bench yielding a cannel-like coal, but the lower bench is of ordinary bituminous coal.

The coal here exibits a well-defined south or south-east dip. It lies about 1635 feet above tide, or forty feet lower than the Davis opening.

At Kester's bank the coal lies at an elevation of about 1600 feet, thus showing the strongest dip to be south by east. Near the mouth of the drift the bed shows three and a half to three feet eight inches of coal, with a small slate parting about one foot from the bottom. It has a carbonaceous slaty roof similar to that at Hartshorn's bank. These banks are probably opened on the Kittanning Upper coal bed C'.

Heitsenrether's bank, opened several years ago by Mr. Mason G. Bloom, at the cross-roads two miles south-east from Pennville, shows only a thin two-and-a-half- to three-foot bed. It lies about forty feet below the limestone found at Mr. Widemire's place. This limestone is about four or five feet thick and is overlaid by two feet of fire-clay, above which there is a small eighteen-inch or two-foot coal. Thirty feet above this Mr. Bloom has plowed up the smut of a small coal. These three coals are doubtless the Freeport Upper, Freeport Lower, and Kittanning Upper beds, E, D, and C', the limestone being the Freeport Lower Limestone. The latter lies at about 1710 feet above tide.

Limestone is also reported as having been dug near Mr. Elisha Moore's house (or orchard), and also near the cross-roads near E. M. Davis' house. These points are about fifty feet lower than the Widemire quarry, and therefore show the existence of a west or north-west dip.* East of Pennville, and east of Little Anderson's Creek, all of the upper coals seem to be of small size, and while few openings have been made on the lower beds, these latter do not seem to be of much value.

Since writing the above some facts developed by Mr. John Fritz, who has spent most of this summer in prospecting in this locality, place a somewhat different construction upon the relative positions of the four coal openings described above.

Near the Rafferty place Mr. Fritz has found what may be called a "five-foot" bed, which is doubtless the same with the coal at the Davis and Miller openings, and about forty feet, more or less, lower down in the hill, he has found a bed with a top bench exactly like the top coal at the Hartshorn bank. It therefore seems probable that the Hartshorn, Kester, and Mason G. Bloom openings are on the Kittanning Upper coal (Bed C'), and that the Davis and Miller banks are opened on the Freeport Lower coal (Bed D).

Mr. Fritz has also opened these two beds on the Daily place near Keenan's house, but the upper bed (D) is here quite variable, (3 to 4½ feet,) and the lower bed does not show the *cannel-like* coal of the Hartshorn bank.

The old bank on the Patrick Daily place is said to show from five to six feet of coal. Mr. Fritz regards it as Bed B. I did not visit this opening.

The *Freeport Upper Coal* (E) is probably rather thin in this township. It may reach a local thickness of nearly four feet, but it probably averages not more than two to two and a half feet.

The *Kittanning Middle Coal* (C) is probably quite thin. I saw no banks on this bed.

*Provided the diggings were on the same bed, which appears most probable.

The *Kittanning Lower coal* (B) while thick at Daily's, is probably a much smaller bed in other parts of the township. It has been opened at very few places, and these have all long since fallen shut.

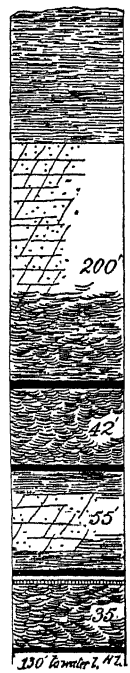
The *Brookville Coal* (A) has not been opened. It lies near water-level along Bell's Run and Little Anderson creek. It is reported as a "three-foot vein."

17. Pike Township.

This lies south of Pine and west of Lawrence township, and extends southward to Little Clearfield creek.

The central line of the *Second basin* crosses the southern part of the township, bringing nearly two hundred feet of Barren measures down into the hills near Bloomington.

A section compiled between Curwensville and Bloomington is given below. It shows nearly the same features as the Clearfield section.



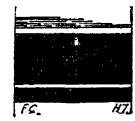
Section of Measures between Curwensville and Bloomington.

Barren measures,—slate, shale, and shaly sandstones, Mahoning sandstone, a thin shaly sandstone, Shale,	200′	
Freeport Upper Coal, Bed E, (Smut) about,	3′	
Shale,	42′	
Freeport Lower Coal, Bed D, (reported,)	2′	
Shale, with some little sandstone,	55′	
Kittanning Upper Coal, Bed C′,	3′	4″
Fire-clay,	2′	
Johnstown Cement Bed, (Limestone,)	2′	
Shale,	35′	
Kittanning Middle Coal, Bed C, (reported,)	2′	
Interval to river level, about,	130′	

The *Kittanning Upper Coal*, Bed C′, is the bed on which nearly all the banks are situated. At a number of banks opened on this bed in the bluff overlooking the river one mile south-east of Curwensville the bed shows:

Slaty shale roof.				
C'.	Bony coal,		2″ to	4″
	Coal,	2′	2″ to 2′	8″
	Slate, (sulphurous,)		2″ to	3″
	Coal,		10″ to	6 ·
Fire-clay, about,		2′		
Limestone, (Johnstown Cement Bed,)		2′		

49.



This bed furnishes a bright, black, shining, columnar coal with only a small amount of sulphur, and yielding a small percentage of ash,—in other words, a fuel of high order.

In the region between Bloomington and Little Clearfield creek a strong north-west dip pervades the rocks, so that the coal is here more than a hundred feet higher than when opened near Curwensville. This rise to the south-east continues over into Knox township, and near the Pleasant Ridge School House on the "Barrens" road the *Mahoning Sandstone* is seen at an elevation of 1650 feet, more or less, above tide.

A large number of country banks have been opened on beds A and B, and possibly on an *Intra-conglomerate coal* in the neighborhood of Curwensville, but they rarely found more than two and a half to three feet of coal, and that of rather poor quality and often very sulphurous. These workings have, therefore, been abandoned, the banks have long since fallen shut and the beds cannot be measured.

About one mile west of Curwensville near the road to Pennville, the Freeport Lower Coal (?) has lately been opened by Mr. M. McClure. The bed is said to be three feet to three feet four inches thick, but is soft and dirty. It lies near the top of the hill. I am inclined to think that this may be the same with the bed opened south-east of Curwensville,—the Kittanning Upper Coal, Bed C'.

One mile further west the Freeport Upper (or Lower?) coal has been opened near Mr. William Bennett's house.

[The following facts are mentioned in Report H.]

One half mile below Curwensville, on the north side of the Susquehanna river, thirty feet above the stream, there is an outcrop opening on a coal bed (Bed A) on the lands of Patton and Hoover. The outcrop shows :

Black slate roof,		4'
A.	Coal smut,	0 6" to 8"
	Fire-clay,	2 2
	Coal smut,	1 1
Fire-clay floor, sandy,		2 6

Massive sandstone underlies the fire-clay for ten feet. Thin bedded sandstones and coarse brownish and grayish shales overlie the coal for eighty feet to a small bench, then ninety feet of shales, with small pieces of sandy hematite through the mass, to an old opening, (now fallen shut,) on the "four-foot" bed of coal, then shales twenty feet to hill top.

These Curwensville coals are of excellent quality, but no bed rises above three feet 3 inches as far as opened.

On Anderson's Hill, about one and a half to two miles west of Curwensville, an impure *ferruginous limestone* shows along the main road. A fire-clay ten feet thick overlies it, and then a coal smut, called a "thirty-inch" coal.

Four miles above Curwensville, on the Susquehanna river, at J. Farwell's, is an exposure strongly resembling the above. The same impure limestone shows, with coal reported above and a yellowish and grayish sandstone underlying. As this exposure is near the center of the synclinal axis, while Anderson's Hill is rising rapidly to the second anticlinal axis, the difference in level is easily explained.

Analyses of this so-called "*carbonate ore*" were made by Mr. McCreath; but the specimens forwarded to him yielded only 4.80 per cent. and 8.00 per cent. metallic iron.

18. Lawrence Township.

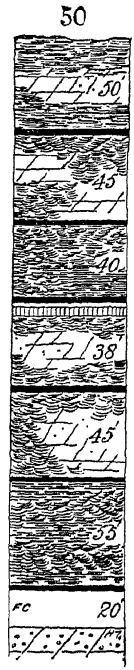
This is one of the largest townships in the county. It extends from the northern boundary of the county south to Little Clearfield Creek, lying between Goshen, Bradford, and Boggs townships on the east, and Huston and Pike townships on the west.

The central line of the *Second Basin* runs through the township south of the river.

The following section is taken from the Clearfield county atlas, for which it was prepared by Mr. Harris Hoover. I find it substantially correct for the vicinity of Clearfield, and therefore reproduce it here, indicating in parentheses the names of the coals, etc.:

Section near Clearfield.

Slate, (in hilltops, sometimes shows Mahoning SS.,)		50′
Coal, (Freeport Upper—Bed E,)		3
Sandstone and shale,		45′
Coal, (Freeport Lower—Bed D,)		2′ 6″
Shale and slate, (with Freeport Lower limestone near top,		40′
Coal, (Kittanning Upper—Bed C′,)		2′ 6″
Interval, ("say,")		2′
Limestone, (Johnstown Cement Bed,)		4′
Sandstone, (generally slaty shale and shaly SS.,)		38′
Coal, (Kittanning Middle—Bed C,)		3′
Sandstone and shale,		45′
Coal, (Kittanning Lower—Bed B,)		2′ 6″
Shale and slate, (Clarion S. S.,)		55′
Coal, (Brookville—Bed A,)		2′ 6″
Fire-clay,		20′
Sandstone,	No. XII,	60′
Conglomerate,		150′



The interval given between beds D and E is somewhat too large, and that between D and C′ appears rather small. Otherwise the intervals agree very well with my measurements.

It will be observed that the place of the *Clarion sandstone* is occupied by slate and shale. This is plainly seen near the town of Clearfield, but the nose of the hill above the Fire Brick Works shows that this sandstone begins to come in as we go east. At the railroad bridge over Clearfield creek the *Clarion sandstone is finely developed*, and appears to extend downward without any break the Conglomerate measures. I could find no trace of Bed A, nor of its underlying fire-clay in this vicinity.

The highlands between the West Branch of the Susquehanna and little Clearfield creek catch about 50 to 100 feet of *Barren measures*. Throughout this area the measures

appear to lie quite flat, and it is evident that the basin is broad and flat.

All the coals have been opened and worked, but nearly all the openings have fallen shut except those on the *Kittanning Upper coal*, Bed C′.

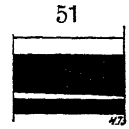
This bed commonly shows:

Slate roof.

C.	Coal,	2′ 0″ to 2′ 4″	
	Slate,	1″ to 3′	
	Coal,	8″ to 10′	

Fire-clay floor.

51



Such is its character at Read's and Thompson's banks in the south-western part of the township, and near Clearfield. It rarely yields more than three feet of coal.

The Freeport Lower Limestone was opened at Mr. Owens' place two miles east from Clearfield. An analysis of this limestone by Mr. McCreath shows (Report H):

"Carbonate of lime,	91.888
Carbonate of magnesia,	1,892
Sulphur,	.135
Phosphorus,	.031
Insoluble residue,	2.770

The limestone is dark blue and crystalline."

The lowest coal of the series, Bed A, is extremely variable, and will doubtless prove of little value. It sometimes measures over three feet in thickness, but commonly carries a bad sulphurous slaty parting. It is often almost, if not entirely, absent.

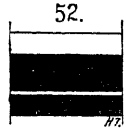
The Kittanning Middle coal, Bed C, furnishes good coal, but is rarely more than two feet thick.

The Kittanning Lower coal, Bed B, is sometimes over three feet thick, but often contains a thick parting of slate which sometimes measures ten inches.

At Swatsworth bank the coal opened is reported thus:

C′?	Cannel slate,	1′ 0″
	Coal,	2′ 0″
	Slate,	2″
	Coal,	1′ 0″

52.



I did not visit this bank, but believe it is most probably opened on the Kittanning Upper bed (C′), but I am informed that the owners think it is on a higher bed, Bed E

North of Clearfield the measures rise steadily towards the *Second anticlinal axis*, so that while the ground three or four miles north of the river is very high, we find the hills topped by only the lower portion of the coal measures, and six or seven miles (in an air-line) north of Clearfield on the road leading towards the old Caledonia pike, we find the summits sandy and rocky and covered with blocks of conglomerate. The summits on this road are 2100 to 2150 feet above tide.

One mile and a half north-west of Clearfield we find several banks opened. Mr. Thomas Duckett has two banks opened. The lower bed shows about two feet and a half of coal with a slate parting one half to one inch thick, five inches from the bottom. This bank is opened at an elevation of about 1310 feet above tide, and is probably on the Kittanning Middle coal, Bed C. The Joseph Shaw bank on the opposide side of the ravine is about twenty feet lower, but is thought to be on the same bed; it shows but little more than two feet of coal.

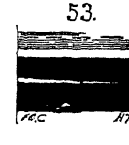
Forty-five feet above the former opening Mr. Duckett has a bank opened on what is probably the Kittanning Upper coal—Bed C'—at an elevation of about 1355 feet above tide. The coal is somewhat variable, showing:

Slaty shale roof.

C'? { Coal, sometimes bony, ... 6''
Coal, ... 1' to 1' 4''
Slate, ... 0'' to 2''
Coal, ... 1' 6''

Fire-clay floor.

53.



Two beds are supposed to lie in the hill above this bank, one of which has been opened on the Showers place, where it showed five feet of coal; but a pinch or fault was encountered, the bed ran down to an insignificant thickness, and the opening was abandoned. This was probably Bed D, the Freeport Lower coal.

The old *Karthaus-Caledonia pike* runs for about three miles through the northern part of the township, through sandy "Barrens" formed by the conglomerate, which is here elevated by the Caledonia sub-axis. But as we approach the Elk county line, we find these rocks rapidly

sinking to the north-west (or north-west by west) towards Caledonia, so that the coal measures are soon brought down into the hill-tops, and the character of the land is similar to that made by the coal measures in other localities. The summits near the Huston township line are also of the same character.

[Report H has the following numerous sections and analysis of the coal beds worked in this township.]

On Mr. A. H. Shaw's land, coal has been opened two thirds of a mile east of Clearfield. The mine is now fallen shut, but is reported as having yielded as follows:

Shales, rusty,	25′	
Coal,	1	4″
Slate,	0	10
Coal,	1	8

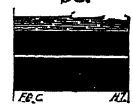
54

"The coal hard, and burning freely in the grate." Some 80 feet above the last, a small 18-inch coal bed was opened, hard and bright coal, but too small to work.

A. M. Hill's mine, two thirds of a mile east of Clearfield, shows:

Roof, black slate,	4′	
Coal, block,	1	2″
Slate,	0	1
Coal,	1	8
Soft whitish fire-clay floor.		

55.



The coal shows much pyrites and the slate is filled with it.

An average specimen of the coal gives, by analysis (McCreath):

"Water,	0.380
Volatile matter,	22.280
Fixed carbon,	67.995
Sulphur,	2.455
Ash,	6.890
	100.000

Coke, per cent, 77.34. Color of ash, dirty gray, with reddish tinge. The percentage of sulphur is heavy. The coal is shining, columnar, very friable, with much pyrites and charcoal in veins."

At Humphrey's Bank, one mile west of Clearfield, on

Widow's Run, 195 feet above the Susquehanna by barometer, the coal shows:

Black slate roof.		
Bony coal and slate,	0'	1½"
Coal,	2	
Fire-clay floor,	1	6

The coal has been used in the Clearfield gas works.

A bench shows on the hillside 45 feet above the coal, and a small bed was once opened in the valley below at water level, 50 feet below the mine.

A fair average specimen of Humphrey's coal gave on analysis (McCreath):

"Water,	0.410
Volatile matter,	21.800
Fixed carbon,	72.903
Sulphur,	1.087
Ash,	3.800
	100.000

Coke per cent, 77.79. Color of ash, reddish.

The coal is bright, friable, fracture showing chisel faced forms. Pyrites in veins."

Mason's coal bank is opened about one half mile west of Humphrey's, and on the upper bed. It measured:

Black slate roof,	4'	
Bony coal,	1	
Coal,	2' 4" to	2 6"
Fire-clay floor,	1	6

The coal shows some irregular small slate partings.

An average specimen of the coal from the upper part of the main bench, yielded (McCreath):

"Water,	0.550
Volatile matter,	22.650
Fixed carbon,	72.616
Sulphur,	1.334
Ash,	2.850
	100.000

Coke per cent, 76.80. Color of ash, red.

The coal is bright, columnar, containing veins of charcoal and pyrites."

An average specimen of the lower part of the main bench yielded, on analysis (McCreath):

"Water,	0.480
Volatile matter,	22.320
Fixed carbon,	59.788
Sulphur,	4.232
Ash,	13.180
	100.000

Coke per cent, 77.20. Color of ash, purplish.

The coal has a glossy luster, is very friable, and contains a very large amount of iron pyrites."

Such an analysis condemns entirely the lower part of the bed.

Another opening on the "Humphrey's Bed," made 600 yards east south-east of the first, showed about the same thing—two feet of good coal.

J. Shaw's banks.—About one and a half miles north of Clearfield town, on the waters of Stone creek, Mr. J. Shaw has opened two coal beds, 55 feet apart.

The lower bed, 175 feet above the Susquehanna by barometer, measured:

Black slate roof,	3′ or more.
Bony coal,	0′ 1″
Coal,	2′ 3″
Fire-clay floor, hard.	

An average specimen yielded on analysis, (McCreath):

"Water,	.520
Volatile matter,	21.030
Fixed carbon,	67.133
Sulphur,	.767
Ash,	10.550
	100.000

Coke, per cent, 78.45. Color of ash, reddish gray.

The coal is bright, shining, very hard, with slate and charcoal in veins."

The upper bed, 230 feet above the Susquehanna river, by barometer, measured:

Black slate roof,	4′
Coal, hard, some bone mixed,	0′ 6″
Coal,	2′ 5″
Fire-clay floor, hard.	

Some few non-persistent knife edges of slate run through the coal, which on the whole looks well.

About one half mile west of these openings are the "Old Collins mines," also opened on a branch of Stone run. Here the same two beds show 55 feet apart. Between these beds the rocks are massive sandstone, fine-grained, brownish, micaceous.

The lower bed measured:

Black slate roof.		
Bony coal,	0'	3½"
Coal,	2	
Fire-clay floor, hard.		

The upper bed measured:

Black slate roof.		
Coal, hard, some slate mixed,	0'	4"
Coal,	2	8
Fire-clay floor.		

The coal looks very well and does excellently for house use.

R. Shaw's bank.—Five hundred yards south-west of these mines R. Shaw has opened up this upper bed. It shows:

Black slate roof.		
Bone Coal,	0'	9"
Slate, persistent,	0	3
Coal,	1	7
Fire-clay floor, hard.		

An average specimen of this coal yields, on analysis (McCreath):

Water,	0.870
Volatile matter,	21.680
Fixed carbon,	68.928
Sulphur,	1.302
Ash,	7.220

Coke, per cent, 77.45. Color of Ash, pinkish.

The coal has a dull luster, is columnar, very friable, iridescent, with Pyrites and charcoal.

The coal in this mine is cut down to a smaller size than in any other opening on the same bed examined. The coal beds of this section are *singularly free from irregularities* of floor or roof, carrying their regular, very moderate thickness of coal and persistent slate partings for considerable distances almost unchanged. But in this mine the floor is

very uneasy, *rolling* up at times two or more feet, and disturbing the coal everywhere in the mine.

The general dip seems to be locally to the south-west.

These beds, as well as those to be described opened higher up the Susquehanna river and over on Clearfield creek, though fairly good in quality, are all small. The country is cleared and thoroughly cultivated for miles in all directions, and the numerous openings made for local use and the trial openings are sufficient to render it extremely doubtful whether any one of the coal beds contained in the 400 feet of lower productive coal measures showing in this place can ever be expected to reach a marketable size over any considerable area. It would certainly require at least a clear 3 foot 8 inches to a 4-foot coal bed to compete with the basins to the eastward, and no such regular and even 4-foot bed has ever been opened in the vicinity of Clearfield, although some special mines may reach close up to it. Of course there is a steady and increasing demand for coal for home use, and for this purpose these mines will continue to be worked.

[The fire-clay which is opened at Clearfield will be discussed in a separate chapter in connection with the other fire-clay deposits examined in the First and Second Basins, the Sandy Ridge, the Blue Ball and the Woodland fire-clays.]

The measures underlying the Lower Productive Coal Measures at Clearfield are given by the record of a boring for oil made at that place a number of years ago. The boring records, as well as samples of the rocks passed through, are carefully preserved by Josiah W. Smith, Esq., of Clearfield, by whom they were kindly loaned to the Survey.

One small coal, six inches thick, is reported as having been passed through a short distance below water-level. The record is :

Clearfield Oil Boring Section.

at 45' deep, ferruginous sandstone.
62 " brown sandstone.
78 " light-colored sandstone.

at 90'	deep,	coarse iron-stained sandstone.
96'	"	black slate mixed with sand.
100'	"	light-colored, crumbly, iron-stained sandstone.
137'	"	soft gray slate.
150'	"	crumbly, iron-stained sandstone.
170'	"	white sandstone.
180'	"	grayish white sandstone.
200'	"	to 215', dark-colored slate.
233'	"	light gray sandstone.
288'	"	to 300', clay slate.
320'	"	slate.
345'	"	red slate.
400'	"	to 412', reddish slate.
450'	"	to 490', light-colored, grayish, slate.
		Not recorded until at
855'	"	to 860', light-colored sandstone.

At between 400' and 500' below the surface weak brine was struck, and at between 700' and 800' *strong brine* was found. An analysis of this brine, by Prof. Geo. H. Cook, of New Jersey, gave:—the copy furnished by Mr. Smith:—

Common salt,	69.010
Chloride of Bittern, calcium,	25.090
Chloride of Magnesian Bittern,	5.900
	100.000
Water,	88.952
Salt,	7.591
Chloride Calcium,	2.767
Chloride Magnesium,	.655
Oxide of Iron,	.007
Silica and Earth,	.028
	100.000

A gallon of this brine weighs 8¾ pounds, and contains two thirds of a pound of salt. 84 gallons contain 56 pounds of salt or one bushel."

Passing up the Susquehanna river and near the bridge over the river 2 miles below Curwensville, about the largest and best coal bed in this division of the basin was opened many years ago by Mr. Reed. "It lies between 80 and 90 feet above the river, dipping at a considerable angle to the north-west. The coal bed is here 3 feet 6 inches thick. It forms an excellent fuel as it has but little sulphur. Like most of the coals of the First and Second Coal basins it affects a species of columnar structure, being traversed by innumerable vertical fissures which render it somewhat friable.

Prof. W. R. Johnson's analysis gives:

Volatile matter,	27.000	in 100 parts.
Fixed carbon,	73.000	" "
Earthy matter,	5.300	" "

Coal columnar, cubical, brittle, jet-black, with great luster."

19. Goshen Township.

This extends from the north line of the county south to the West Branch of the Susquehanna river, lying between Lawrence township on the west and Girard township on the east. It therefore lies principally on the north side of the Second basin.

The coal measures occupy the surface for four or five miles back from the river, but as we go north the rocks rise more rapidly than the surface, and we find only the lower beds extend further north than four miles from the river, except in the extreme eastern part of the township.

Trout run and its branches, and a number of smaller rivulets flowing into the Susquehanna, cut deep ravines and greatly reduce the available coal area. The spur lying between the two branches of Trout run is just high enough to catch the Freeport Lower (and upper?) coal—Bed D—but the ridge is so narrow that its workable area must be small, even if it has sufficient cover to insure hard coal.

Between Lick run and Trout run the Freeport Lower coal, (K. U. C?,) Bed D, lies in the summits with very little cover. I saw no opening on the bench made by this bed.

Several banks have been opened on the Kittanning Upper and Lower coals—Beds C′ and B—but they are reported as being not more than three feet thick; the latter, however, is occasionally reported as showing four feet thick.

Limestone is reported on the top of the hill near Squire Shaw's place; it is doubtless the Freeport Lower limestone and the coal forty feet, more or less, below it, the Kittanning Upper coal—Bed C′.

Going north from Shaw's cross-roads, the last settlement passed is at the Mrs. Spence farm, north of which the hills for a short distance are capped by coal measures, but we soon find the lower rocks coming up, so that two miles farther north, while the summits are three or four hundred feet higher, we find the ground sandy and covered with blocks of conglomerate.

In the vicinity of Shawsville, several banks have been opened on the lower beds, but have long since fallen shut. Bed B, the Kittanning Lower coal, is exposed in an outcrop on the road leading from Shawsville northward through P. A. Livergood's farm. The coal here lies about 1350 feet above tide, and shows about three feet thick with a clay shale parting four or five inches thick one foot above the bottom of the exposure. Beneath the coal a slate band makes the bottom of the gutter, beneath which another bench of coal will probably be found. The bed has a blue-black slate roof.

Eighty-four feet above this coal the Kittanning Upper coal—Bed C'—has been opened on Mr. C. H. Wood's place, but the bank has fallen almost shut.

This coal measures full four feet or more with a sandstone roof, but the upper foot seems to be bony or slaty. However, as my light went out when in this opening, and my last match was gone, I was not able to make a satisfactory measurement of the bed. About thirty feet above this bank a bold terrace marks the probable outcrop of the Freeport Lower coal—Bed D.

The coals here dip to the north,* but going north the dip soon changes and the measures rise rapidly, so that at the new house on Sheck's place one of the Freeport coals was struck in a well at about 1600 feet above tide, thus showing a south dip of at least 100 feet in a distance of one mile. The well is reported as 2½ to 3 feet in the coal and not through.

Two miles further north the Freeport Lower coal has

*This north dip is caused by the local anticlinal axis south of the river in Bradford township.

been opened in a prospecting shaft on Mordecai Livergood's place, at an elevation of about 1700 feet above tide. The bed here shows five feet and one inch thick, with a slaty shale roof and fire-clay floor.

The old opening on the John A. Murray place, at which the coal is reported four feet thick, was probably on a lower bed.

The northern part of the township is a complete wilderness. Only one road that deserves the name traverses this part of the township—the old Karthaus-Caledonia pike. This is now much grown over with brush, and so closed with fallen timber and brush cut to confine the cattle, that it is impassable to wagons, but may be traversed on horseback. It runs across the township in a nearly east and west course.

The land along this old pike would make very fair farming land, for the Driftwood axis crosses the township south of the pike, and the surface is here made by coal measure shales. As we pass westward towards Lawrence township the Conglomerate again appears in full force, making a large area of Barrens near the township line.

The thickness of coals caught in this *sub-basin* along the old pike is not easily determined. I saw enough to convince me that at least 140 feet of coal measures are present at some points, which would be sufficient to insure a large area of Bed B with good cover. I doubt whether the Freeport coals exist in this area. They may be caught in some of the higher knobs along the center of the sub-basin, but it is not probable that they will be found to cover a large area, or that they will have sufficient cover to insure good coal. However, it will not be safe to assert either their absence or presence until a more careful examination is made than I was able to make in my hurried trips across this wilderness.

The beds of Goshen township are therefore—

Freeport Upper Coal—Bed E. Found only over a small area; data insufficient; probably averages about three feet.

Freeport Lower Coal—Bed D. Only a comparatively small area with sufficient mining cover; a five-foot bed in eastern part of township; probably not more than three feet and a half in western part of township.

Kittanning Upper Coal—Bed C'. Found over a considerable area. Fully four feet thick in eastern part of township; two and a half to three feet in western part of township.

Kittanning Middle Coal—Bed C. Probably about two and a half feet thick; ranging between two and three feet.

Kittanning Lower Coal—Bed B. Probably ranges from three to five feet; sometimes contains a bad fire-clay shale parting.

Brookville Coal—Bed A. Reported as a "three-foot bed;" no reliable data; probably not a valuable bed.

Mercer Coal—Intra-conglomerate bed about 150 feet below Bed B. Old workings on this coal said to show over three feet of coal.

20. Girard Township.

This extends from the Cameron county line south to the West Branch of the Susquehanna river, lying between Goshen township on the west and Covington township on the east.

In the southern part of the township—south of "The Knobs"—the *Mahoning Sandstone* is found in all the high land.

In the hills near the river the rocks seem to lie nearly flat, but a short distance north of the river the measures begin to rise rapidly towards the second anticlinal axis. The dip is at least one hundred feet to the mile.

On the road leading north-west from the Deer Creek bridge we find two old coal banks, both apparently opened on the Kittanning coals. The first bank is on the Green farm, and at an elevation of about 1365 feet above tide; the second is on the Mignot place, at an elevation of about 1415

feet above tide. This bank may possibly be on the Freeport Lower coal, but its structure resembles the Kittanning Upper (Bed C') coal. It is thus reported by Mr. Mignot:

Slate roof.
Coal, ... 1' 6"
Slate, ... 4"
Coal, ... 2' 0"
Fire-clay floor.

56.

At the Robert Green bank the coal is reported as being "four feet thick." This is undoubtedly opened on one of the Kittanning beds, but I was not able to determine on which one.

In the vicinity of the Widow Murray's place the top of the *Mahoning Sandstone* is apparently about 1550 feet above tide, corresponding to an elevation of about 1250 feet for the top of the Conglomerate, No. XII.

Several banks have been opened in this vicinity. On the Alexander Murray place a coal showing scant three feet thick, but of good quality is opened at an elevation of about 1340 feet above tide. This is doubtless Bed C. Forty feet below this bed Mr. Murray states that there is the smut of another bed, which is, therefore, Bed B,—the Kittanning Lower Coal.

This same coal was also opened many years ago on the Dermineur place.

The Kittanning Upper Coal (C') or the Freeport Lower bed (D) was opened some years ago near Peter Beausigneur's house near the Widow Murray place, at an elevation of about 1415 feet. This bank is now closed.

A large number of banks have been opened on Beds B and C in the southern part of the township, but these have nearly all been allowed to fall shut, and very little reliable information can now be obtained concerning the thickness or character of the coals. The Freeport Upper and Lower coals (Beds E and D) are not opened, and I could obtain no information concerning them.

Going north from the river in the direction of the Knobs the rocks rise rapidly, but as the surface also rises we find the Freeport group still in the hills in the vicinity of "The

Knobs." The high land between the headwaters of Deer creek and Sandy creek and the "Knobs" are capped by the Mahoning Sandstone, but going north from the Big Knob towards the "Globb place" we find the *Clarion Sandstone* and rocks of the Conglomerate Series coming up to the summit of the ridge and making a great stretch of rocky and sandy ground known as the "Barrens."

As we approach the "Globb place" these rocks are apparently sinking slowly to the north-west, so that the surface shows some very good land.

The *Driftwood axis* therefore passes a short distance south of the Globb place.

Since my examination of this township I learn that the bed worked near Bald Hill run many years ago has been reopened and found to measure four feet and seven inches. This is the Kittanning Lower coal,—Bed B. About eighty feet above this coal the Kittanning Upper coal,—Bed C',—has also been opened by a prospecting shaft, and is reported as showing over four feet of coal.

An *Intra-conglomerate coal*, lying about one hundred and fifty feet above river-level, was opened and worked many years ago, near Bald Hill fording; the coal was shipped down the river in arks. This opening has long since fallen shut. The bed is reported as being about three feet thick.

The beds of Girard township may be summed up thus—

Freeport Upper Coal (E.) This coal was not seen. Its bench is seldom well marked. It is probably thin.

Freeport Lower Coal (D.) I saw no openings in this coal in Girard township. From openings in Goshen and Covington townships, I believe it may reach a thickness of four or five feet in this township.

Kittanning Upper Coal (C'.) This may be called a "3 to 4 foot bed," but in some localities measures over four feet.

Kittanning Middle Coal (C.) This is from two to three feet thick, and yields coal of very fair quality.

Kittanning Lower Coal (B.) May be called a "four-foot bed." Probably contains a clay shale parting in some parts of the township.

Brookville Coal (A.) No reliable data.
Intra-conglomerate Coal. About three feet thick.

21. Covington Township.

This lies between Girard and Karthaus townships. Its north line is formed by the Cameron county line, and the West Branch of the Susquehanna forms its southern boundary.

It has been settled principally by French, who still retain many of their national habits and manners. French is spoken in their every day life, but most of them understand and speak English.

The northern part of the township is an uninhabited wilderness, but the southern part is thickly settled.

Over the greater part of this area the rocks dip gently south and east away from the *First anticlinal axis*, but in the region between Mulsenburg and Central Point the dip is strongly to the east towards the Karthaus canoe-shaped basin. Thus, on Bigleman Run, we find the top of the Clarion sandstone at an elevation of about 1325 feet above tide. A short distance east of Flood's hotel the Karthaus big bed is opened at an elevation of about 1410 feet, while at Karthaus it lies at about 1320 feet above tide.

At this opening beyond Flood's, the coal is a beautiful five-foot bed of clean, bright, shining, columnar coal. Going west towards Flood's, the bed seems to rise rapidly. It has not been found in the high land at Flood's.

About one mile east of Flood's, Mr. Sayre is opening a bed of coal at an elevation of about 1390 feet above tide. At the time of my visit they had four feet of smut. I am informed that they have since then driven ahead into hard coal, and find the bed about four feet thick but with a bad parting. This is probably the Kittanning Upper or Middle coal.

Thirty-five feet below this coal Mr. Sayre struck a coal in digging his water well. The well was sunk two feet and

a half into the coal, when the water came in in such quantity that further sinking was impossible. This is doubtless one of the Lower Kittanning coals.

It is exceedingly doubtful whether the Freeport coals exist in any part of the township west of Flood's hotel. The *Clarion sandstone* and Kittanning shales form most of the surface in the French settlement.

One of the Kittanning coals was opened and worked many years ago at Frenchville, but has long since fallen shut. It is reported as a "four foot bed."

Going out the old Caledonia pike from Flood's north-west, we find the rocks steadily rising towards the First anticlinal, and at a distance of about three miles—beyond Kune's place—the Conglomerate comes up and forms the country rock. Beyond this we find nothing but an unimproved wilderness.

The proximity of the Reiter and other mines on the Karthaus big bed has discouraged the residents of this township from attempting to mine from the smaller beds known to exist throughout the French settlement.

22. Karthaus Township.

This lies in the north-east corner of the county west of Covington township, and adjacent to Cameron county on the north, and Clinton county on the north-east. The west branch of the Susquehanna forms its northern and eastern boundary, separating it from Morris township and Centre county.

The *Horse-Shoe bend* is a marked geographical and topographical feature. At the loop of the bend the Moshannon empties into the river, meeting it full in the face—the Moshannon here flowing north-west, and the river south-east. This loop or bend is doubtless formed by the synclinal axis, like Brady's bend on the Allegheny river and many other similar loops that owe their origin to the presence of a synclinal axis.

The synclinal axis apparently crosses the bend near Mr. J. W. Michael's place.

The Karthaus "big bed" which is doubtless the Freeport Lower coal, Bed D, extends over a comparatively small area in this township. It is caught in the hilltops with very little cover, and is, moreover, confined to the hills lying close to the river.

Going north and north-west, the country rises rapidly, but the rocks rise more rapidly still, so that a short distance beyond the Widow Hertlieu's place the Conglomerate comes up and forms the country rock. The northern part of the township is in every respect similar to the northern part of Covington township. It is conglomerate waste uninhabited and unimproved.

The Karthaus big bed D, as shown by the opening recently made by Mr. Whitehead, shows a thickness of considerably over six feet, with a one to two-inch parting about one foot from the bottom and some "bony" on top; it will probably *mine* five to five feet and a half of coal.

In other localities the bed shows sometimes four and a half, sometimes five, and occasionally six feet thick, but it will rarely yield more than five feet or five feet and three inches of clean coal.

The Kittanning Lower Coal—Bed B—is reported as being four feet thick at many localities in this township. Very little is known of the other beds of the series. Fifty years ago the measures were thoroughly explored by the Karthaus Iron Company. The following section is reproduced from the report of the First Survey:

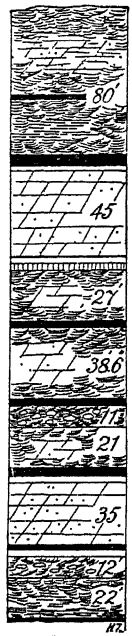
Karthaus Iron Company's Section.

It is extremely difficult to harmonize this section with the typical sections compiled elsewhere. The letters in brackets show that this cannot be satisfactorily done. I am inclined to think the intervals are very much exaggerated by the strong dip, or that one of the coals has been duplicated—that marked [C ?] and [C or B].

Slaty sandstone (up to summit of the hill, 565 feet above the river), said to contain a coal bed 2 feet thick, [E]	79′	
Black slate,	1	
Coal (479 feet above river), [D]	6′	
Fire-clay, poor [with some iron ore],	2′	6″
Brown sandstone,	45′	
Coal,	0′	10′
Fire-clay, [C′]	2′	
Limestone, silicious, [Johnstown Cement Bed]	3′	6″
Shale and Brown Sandstone,	27′	
Coal, [C?]	4′	
Slate,	1′	6″
Gray Sandstone,	37′	
Coal, [C or B]	3′	2″
Shale, containing 26″ of good kidney iron ore, (Elev. 345′)	11′	
Coal,	1′	
Brown Sandstone and Slate,	21′	
Coal, 1′ / Slate, 0′ 3″ / Coal, 2′ 6″ } [B?]	3′	9″
Fire-clay,	2′	6″
Brown Sandstone,	35	
Coal,	1′	6″
Fire-clay, ferruginous,	3′	
Shales containing 25″ good iron ore, called the "Red ore band" (elev. 268′),	11′	9″
Shale and Slates,	22′	
Coal,	1′	

Sandstone, the "brown rock."
Coal, thin.
Seral conglomerate [No. XII] down to the river 240′.

57.



Coming down the plane just built by Mr. Whitehead I find by barometer the following smuts:

Coal, "Big Bed" (D), ... 480 feet above high water.
Interval about 40 feet.
Coal, thin, underlaid by fire-clay and limestone (C′), ... 440 " " " "
Interval about 38 feet.
Coal, about 2 feet (?) (C), ... 400 " " " "
Interval about 60 feet.
Coal, (B), ... 340 " " " "
Interval with one coal (A) about 140 feet.
Coal, three feet, Intra-conglomerate? . 200 " " " "

About thirty or forty feet above the six-foot bed, a prominent bench marks the outcrop of a thin bed of coal which I have considered as the Freeport Upper Coal—Bed E It is reported as being an "eighteen-inch" or "two-

foot vein." It is underlaid by a bed of fire-clay several feet thick, the lower portion of which seems to contain some kidney ore.

[Quotations from Mr. Platt's report, here republished contain valuable facts as to the coals and ores of this district; as follows—]

The limestone in this neighborhood is for the most part inferior, and only one bed of it, 3½ feet thick, occurs in the series.

Lower down in the measures occur two important beds of iron ore. One of these, at an elevation of 345 feet above the river, is estimated to contain in all 2 feet of good blue kidney ore in 11 feet of shales. The other lies at an elevation of 268 feet above the river. It also exhibits about 2 feet of good kidney ore in a stratum of shale less than 12 feet thick. This band is locally called the "Red Ore," and is of a different variety from that above it. They are both of excellent quality.

This ore (mottled brown, nodular concentric, crust hematitic,) gives by analysis:

Carbonate of Iron,	19 86
Peroxide of Iron,	34.80
Carbonate of Lime,	4.50
Silicia and Insoluble matter,	30.40
Alumina,	1.70
Water,	8.20
Metallic Iron in 100 parts,	33.95

The above description is taken mainly from the Final Report of the First Geological Survey, 1858.

"A specimen of this 'red ore,' forwarded to Mr. McCreath for analysis, yielded:

Insoluble residue,	21.040
Iron,	34 000
Sulphur,	.054
Phosphorus,	.521

The ore is a carbonate, partially converted into Oxide on outside."

Prof. Walter R. Johnson made analyses (in 1838) of the minerals found at Karthaus. He reports as follows:

"Six-foot Coal Bed."

Specific gravity,	1.250 to 1.278
Loss of water in distillation,	0.60
Carbureted Hydrogen and other volatile products,	26.20
Earthy residuum after complete incineration,	5.05
Carbon in the coke,	68.15

In another analysis made in 1844, when testing the efficiency of American coals in the generation of steam for the United States Navy Department, Prof. Johnson gives for the Karthaus "6-foot bed:"

Specific gravity,	1.284
Volatile combustible matter,	19.530
Fixed carbon,	73.770
Earthy matter,	7.000

An analysis of this coal, made for the First Geological Survey of Pennsylvania, is published in Prof. Rogers' Final Report as follows:

Volatile matters,	24.800
Coke,	75.200
Ash,	4.700

Prof. Johnson's four analysis of the Kidney ore read thus:

	1	2	3	4
Specific gravity,	3.397	3.415	3.206	—
Of water at 320°,	1.200	3.900		
Carbonic acid by calcination at red heat,	26.680	6.720	27.420	27.42
Metallic iron,	38.330	50.600	36.100	34.54
Earthy impurities, silica, &c.,	16.670	17.100	26.170	27.34
Specific gravity of pig metal obtained,	7.726	6.240	7.102	—
Oxygen,	—	21.680	10.310	—

Specimen No. 2 was the shell of the carbonate of iron, weathered on the outcrop to a brown hydrate of the peroxide of iron.

His analysis of the "Red Vein" is:

	1	2
Specific gravity,	3.421	3.421
Loss by calcination, water, carbonic acid, &c.,	29.060	29.060
Metallic iron,	35.910	36.070
Earthy impurities silex, alumina, &c.,	20.680	20.380
Oxygen and other volatile products of fusion,	14.350	14.490
Specific gravity of pig metal,	6.787	7.272

Prof. Johnson's analysis of the Upper Limestone (Freeport Limestone) is as follows:

Specific gravity,	2.780
Loss by calcination, water, and carbonic acid,	36.370
Dry lime contained,	36.080
Protoxide of iron,	6.970
Silica,	12.000
Alumina and Manganese,	8.580

The Karthaus basin extends north-east from Karthaus, down the river several miles; the large upper bed of Karthaus entering the hills above the neighborhood of Three Runs. At the latter point a bed of coal 3 feet 2 inches thick has been opened, associated with a layer of lime and one of fire-clay. Just north-east of Karthaus, Mr. Heckendorn works a "five-foot" bed; and a coal mine (now fallen shut) was worked at Snar's mill. A boring made on the West Branch of the Susquehanna, 2 miles below Karthaus, is thus reported:

Surface.	
Sandstone,	72′
Coal,	1 10″
Sandstone, white and red, with soft rocks at bottom,	232
Gray limestone rock.	
Strong salt-water at 393′ below the surface,	393

On *Birch Island Run*, which enters the Susquehanna below Karthaus, near the county line, several beds of coal were developed many years ago. The most important of these was opened on the hill between the forks of the stream. The bed is reported to show 6 feet of coal, and is regarded as the big Karthaus bed. A still higher seam, 4 feet thick, is found on the hill top, about 30 feet over the large bed. Iron ore is found associated with the shales enclosing it. Beneath the large coal, 40 feet, a stratum of limestone 3 feet thick outcrops. On the same property further west two other coal beds have been opened. They are reported as measuring 2½ and 4 feet respectively, and occupy a position lower in the measures than the large seam. These openings are all long since fallen shut, and are re-described from Rogers' Final Report.

23. Bloom Township.

This is nearly square in shape. It lies north of Penn, west of Pike, south of Union, and east of Brady township.

I found considerable difficulty in locating the course of the Chestnut Ridge anticlinal through this township, and this difficulty was occasioned by the apparent flatness of the crest of the anticlinal along the Curwensville and Luthersburg pike. It is evident, however, that the crest of the axis passes close to the Packersville settlement.

The northern part of the township contains only the lower coals; the north-eastern part is occupied mainly by the Conglomerate; the south-eastern part by the lower coals, sometimes catching the Kittanning Upper coal (Bed C'), but in the western and south-western parts of the township the Lower Freeport coal (D) comes into the hill tops.

It is plainly evident that the crest line of the Chestnut Ridge (Second) anticlinal is here rapidly sinking towards the south-west, as at the south-western corner of the township we find the Mahoning Sandstone capping the hills at a somewhat lower elevation than the conglomerate in Pine township.

The dip of the Conglomerate measures, No. XII, on both sides of the anticlinal axis, can be plainly seen in ascending Anderson's creek from Curwensville to Rockton.

As I found no banks being worked in this township, I can give no description of the thickness and character of its coals.

The colored map will show plainly enough to property owners where the Freeport beds may be found, where only the lower coals exist, and where it is almost useless to look for valuable beds.

24. Pine township.

This lies in the mountainous region between the Susquehanna river and Bennett's Branch. It is directly north of Pike township and south of Huston, west of Union and east of Lawrence township.

At present it is an unimproved wilderness of timber land with one small farm located near the center of the township. This clearing is on the Penfield–Clearfield road, about midway between these two places.

The Driftwood anticlinal axis runs through the township from north-east to south-west, passing near or a short distance south of Mr. Smith's farm. It elevates the Conglomerate No. XII to a height of over 2100 feet above tide, forming "Barrens" similar to those in Lawrence, Goshen, and Girard townships.

In the northern part of the township, the north-west dip of the measures towards the Bennett's Branch (DuBois) Basin brings the coal measures down into the hills, so that near the Huston township line the hills are probably high enough to catch the Freeport coals.

Along the Penfield–Clearfield road at about one mile south-east from Smith's Improvement, *red shales* are seen at several places. As the top of the Conglomerate is here far up on the crest of the mountain (possibly in the air) and these red bands are low down in the gorge cut by the north branch of the Upper Moose, I have little doubt but that they mark the horizon of the *Mauch Chunk Red Shale, No. XI*, and have colored the geological map in accordance with this view. This red continues above water-level and is seen repeatedly along the road until within about four or five miles of Clearfield when it passes under water-level.

It is not possible to give any specific information in regard to the thickness or quality of the coals underlying the northern and north-western part of this township, because they are as yet entirely undeveloped. It will be sufficient to state that they—especially the lower beds—will be found to underlie a large area.

The district crossed by the road running from Clearfield to Rockton is merely a great outspread of the Conglomerate, No. XII, here abnormally elevated to an average height of more than 2200 feet above ocean level.*

* My barometer made the summits on this road over 2300 feet above ocean level, but I am inclined to think this is somewhat higher than the actual elevation of this ridge.

The Second or *Chestnut Ridge anticlinal* apparently crosses this road a short distance from the head of Horn Shanty Run. A road here comes into the main road from the north, making a short cut across from the Penfield road above Smith's improvement.

From the elevation of the Conglomerate along this road, it is evident that the axis here presents a dome-shaped elevation somewhat similar to the Wallaceton uplift on the First or Laural Hill axis.

The north dip from this axis towards the center of the Third Basin is one of the sharpest observed in Clearfield county, but this will be discussed with the geology of Union township.

25. Union Township.

This is an almost perfectly square area, lying north of Bloom, east of Brady, west of Pine, and south of Huston township.

As the Second or *Chestnut Ridge anticlinal* crosses, or rather just touches, the south-eastern corner of the township, the whole township lies in the Third Basin. The prevailing dips are north-west and north north-west. Near Rockton the measures pitch in towards the basin at the rate of about two hundred and fifty or three hundred feet to the mile, and a short distance south-east of Rockton the dip is doubtless sharper, for on the mountain in sight of town the Conglomerate rocks are seen at an elevation of at least five hundred feet above the massive rock (Clarion sandstone) near the Mennonite church.

At an elevation of about one hundred feet above this rock, we find the *Mahoning sandstone* capping the hills near Doney's. The distance between these two points is about one mile and a half, and the direction due north, thus showing a dip in this direction of (150 feet in all) at least one hundred feet to the mile.

Between these two points we find two coals opened. One of these is at Keisegle's place. It seems to lie in proper

position for the Freeport Upper bed, but I was at first inclined to place it lower in the measures. It is reported as showing about four feet thick, but contains a bad slate parting.

Forty feet below this bed Mr. D. Laborde has a bank opened on a twenty-seven-inch bed.

Some years ago Mr. E. Oswalt had a bank opened on what was probably Bed B. It is now fallen shut. In the same vicinity a bank was once opened by Mr. Welty, and further down the stream Mr. Brubaker worked a bank. The coal at these banks is variously reported as three feet, three and a half, and four feet thick.

Coal smuts are frequently seen along the road between Rockton and Luthersburg, but they are all to be classed with beds lying lower than Bed D—Freeport Lower Coal.

Going north along the road to the tunnel, *Barren Measures* come into the hills and continue as the country rock after passing Doney's place.

At L. R. Dressler's a coal was once mined by stripping, but only a small quantity was taken out. I am inclined to identify it as one of the thin coal beds of the lower part of the Barren Measures.

I have recently learned that Mr. Anderson has lately opened a coal, reported as being over four feet thick, in the hill opposite Rockton, on the east side of Anderson Creek, but, as I have not visited this bank, I am unable to indicate what bed it develops.

A large portion of this township is unimproved timber land, on which no explorations for coal have yet been made.

26. Brady Township.

This lies in the western part of the county (see the map), adjacent to Jefferson county. It is north of Bell township, south of Huston (Sandy) township, and west of Bloom and Union townships.

The Mahoning waters flowing westward to the Allegheny carry off the drainage from the southern part of the township; but its northern half is drained by tributaries to Sandy Lick creek, which empties through Red Bank creek into the Allegheny.

In the chapter on the Structural Geology of the county the course of the *Third Basin* through this township has already been described.

On the southern and south-eastern borders of the township the high dividing ridge capped by *Mahoning Sandstone*, and marking the location of the Chestnut Ridge (*second*) *anticlinal axis*, plainly marks the south-eastern limits of the basin. All the country north-west of this ridge may be described as a single and rather broad valley, bounded on the north-west by Boon's mountain.

The streams of Brady township do not cut very deep below the average level of the country, and we consequently find that while the hill tops in the southern part of the township oftenare not high enough to catch the Mahoning Sandstone, the streams seldom cut down into the Conglomerate measures (No. XII).

We therefore find the country comparatively destitute of rocky land, and there is very little land that cannot be farmed.

The township is thickly settled—largely by Germans—and many of the farms are equal to any that may be found in Clearfield county.

From the high dividing ridge of the *Second anticlinal*, the rocks dip in towards the center of the Third Basin in a general north-westerly direction, but near Luthersburg there seems to be a marked exception to this, for here we find two well-defined dips, one nearly north towards or rather east of Salem, and the other nearly west or possibly south-west towards Troutville.

At Irvin's hill at Luthersburg we find the *Mahoning Sandstone* at an elevation of about 2000 feet above tide, or nearly as high as the main dividing ridge three miles further south.

This rather abnormal position, and the north and south-

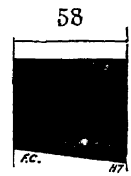
west dips just described, may and probably are caused by the dying away at this point of the *Caledonia* (*Barrens*) *anticlinal.*

This is rendered more probable by the comparative flatness of the measures south of Luthersburg, and the same condition noticeable along the pike for several miles southeast of that town.

There are very few openings in the southern part of the township.

The Freeport Lower Coal (D) is worked at Dunlap's bank which is opened in the dividing ridge between the Mahoning and Stump creek, two miles or more east of Troutville. The coal measures from three feet and six inches to nearly six feet of good, clean, columnar coal with no persistent parting of slate or other refuse. It has an uneasy rolling roof, which changes from sandstone to shale, slate, and even fire-clay in different parts of the bank.

On the north side of the ridge and 190 feet by barometer below the Dunlap opening, Mr. Fost (Faust) has opened a bank on what seems to be the Kittanning Lower Coal (B). The bed here lies a short distance above water-level. It measures :



Fire-clay (?) roof.
Bone and coal, about, ... 1'
Coal, ... 4' 9" to 5' 3"
Fire-clay (?) floor.

This coal may, however, be the Freeport Lower bed ; the same with the Dunlap opening.

The coal contains a considerable quantity of sulphur, which occurs in balls and well-defined layers.

About one mile and a half further up the stream Mr. Pentz is opening a bank on the same bed (B,) which measured near the mouth of the drift :

Slate roof.
Bony coal, ... 3"
Coal, ... 2' 2"
Fire-clay floor.

At another bank, located in the hill opposite the Pentz

opening, the coal is said to range from three to three and a half feet. It shows a considerable quantity of pyrites at both openings.

The same bed (B) is opened at Kopp's (lower) bank, and there measures:

Slate roof.	
Bone,	6″
Coal,	3′ 0″
Fire-clay, (reported,)	3′ 0″
Coal, (reported,) thickness unknown.	

The Upper bank at Kopp's was doubtless located on one of the Freeport beds. It was shut at the time of my visit. A description from Report H will be found on a succeeding page.

About one mile or less from Kopp's bank Mr. Frederick Knarr has a bank opened on Bed A. This opening is seventy-five feet by barometer below Kopp's bank. A measurement gave:

Shaly slate roof.	
Coal,	2′ 4″
Slate and sulphur parting,	2″ to 4″
Coal,	1′ 6″
Fire-clay (?) floor.	

Several years ago Mr. T. F. Rishel began opening a bank on the Freeport Lower coal (D,) in the ridge near his house, on the north side of *Limestone run.* The coal is reported as being four feet thick, but that after driving in a short distance it was cut off by a rock. The same thing is reported as having prevented the opening of this bed in the hill above the Faust (Fost) bank.

A coal, probably one of the Freeport beds, lying at water-level at the south end of the *summit cut* of the Rochester and Pittsburgh R. R., was partly opened a few years ago; but the dip was adverse, and the opening was allowed to fall shut. The coal is reported as being four feet thick, with about fifteen inches of bony coal on top.

An impure *limestone* is exposed in the railroad cutting which may be the Freeport Upper limestone bed, but it apparently lies too high for that stratum. The rocks here dip strongly to the north-west.

A coal has lately been re-opened about one mile east of Salem on the Brockbank place. The bed shows:

Shaly slate roof.	
Slaty coal, (about,)	1'
Coal,	3' 3" to 4' 6"
Bony coal,?	3" to 4"

The coal appeared to be a very good article, but as only soft outcrop coal was being taken out, it was impossible to judge as to the percentage of sulphur it contains.

Forty feet below this opening a coal has been dug into the bed of the run. It has been reported as a "six-foot bed," but I have very little faith in this report.

At an old bank opened on the Smith place, near Salem, the bed worked is reported as a "three-foot vein." From the amount of refuse lying at the mouth of the bank, I judge the coal contained a bad parting of slate. Thirty feet above this old opening the smut of a small bed shows prominently along the road.

On the pike, about two miles south-east from Luthersburg, the smut of the Freeport Lower coal (D) makes a grand show on the side of the road. It was opened at this point some years ago by Mr. John Reams, and is now commonly reported as having been found to be five feet thick. The bed has very little cover at this point, and as the coal was soft and dirty the opening was abandoned.

Going north-west or west from the Kopp, Knarr, Dunlap, Fost, and Rishel openings, we find the measures rapidly descending so that the coals are soon buried beneath water-level along Stump creek.

The Barren measures come into the hills and form the country from Carlisle's mill northward to Du Bois.

The rapid north-west dip towards the central line of the *Third basin* is plainly shown by the *terraces* along all the hills facing Stump creek and Limestone run on the south.

From West Liberty northward towards Du Bois, the measures appear to lie rather flat, so that while the center of the basin is probably near West Liberty, the Freeport coals do not come above water-level until we reach Du Bois.

The coal worked west of the town of Du Bois by the

Rochester and Hildrup companies seems to be the same with the bed worked at Reynoldsville, *i. e.*, the Freeport Lower coal, Bed D.

At the Rochester mine the bed shows very thick, in some parts of the workings approaching seven feet, with a slate parting about two feet below the roof.

At the Hildrup mine this parting is much thicker, and from the appearance of their dump I judge the bed is not in very good shape in this locality.

The old Jones Bros. bank no longer ships coal, and the Sandy Lick Company's workings are not now operated by that corporation.

At the Rochester Company's mine only the screened (lump) coal is commonly shipped to market. The slack is washed in a Stulz washer and coked in a bank of 54 Beehive oven. I am informed that while the company has not carefully investigated the results obtained by the use of this washer, as to the reduction in sulphur and ash, they are thoroughly satisfied with the machine.

Coming eastward, up the Low Grade Railroad, towards the town of Du Bois we find the *Barren Measures* coming down to water-level. This accounts for the absence of this coal in the Du Bois hills—it there lies below water-level. This has been proven by several holes drilled for water in and near the town.

From Du Bois eastward to the *Summit tunnel*, the cuttings on the railroad are all in Barren measure rocks, and at the tunnel we find a thickness of over two hundred feet of these measures.

Between Luthersburg and Rockton the hills are rarely high enough to catch the Freeport Lower coal with sufficient mining cover. The lower coals have been opened on the head-waters of the Luthersburg branch of Sandy Lick creek, but they are all reported as being rather thin—commonly two and a half or three feet thick. The Freeport Lower Limestone outcrops in the road on the Summit at Mr. Line's place.

[The following additional particulars are taken from Report H.]

Two coal beds are developed north-east of Luthersburg. The upper one measures two feet six inches and the lower one two feet six inches to three feet. The lower coal is mined near the Clearfield turnpike, three fourths of a mile east of the town, where it is two feet eight inches thick. Forty or fifty feet above it, on the turnpike, indications of the upper bed are seen resting on fire-clay. The same bed was penetrated in a well on the hill-side at Luthersburg, and proved to be two feet six inches thick. A coal bed one foot thick was cut through by several wells in the higher ground at Luthersburg. The existence of a fourth bed appears to be indicated by springs and black dirt on the hill just east of the town. It gives no evidence of being large. (Rogers' Final Report of Pennsylvania).

About this locality, on the Curwensville turnpike, *limestone* has been quarried; it is also opened on the place of A. Pentz, Jr., one half mile north-east of the town. It occupies only the high ground, and is three to four feet thick, gray, compact, sonorous, and when weathered, yellowish or brownish, from the amount of iron which it sometimes contains. It is burned somewhat for agricultural purposes, but will not make a white lime for plastering.

Kopp's mine (Bed D ?) on the upper bench, is two miles east of Troutville. It measured:

Sandstone.	
Black slate roof.	
Coal, ...	3 6″ to 3′ 8″
Black slate in floor.	

The mine was partially filled with water and could only be imperfectly examined near the entrance. It is stated that the coal measured four feet six inches at the head of the main entry. The present bottom as seen does not look like the true floor, and the additional thickness is every way probable. The roof is good, tough, and dry. The coal was quite tender and friable where examined near the mine mouth; it is said to have been harder when under heavier cover. Some slate was found in irregular layers,

but without any persistent parting. But little pyrites showed in the coal, and in every way it gave evidence of being a valuable coal bed.

The hill rises to the next bench 55 feet higher up and not opened at all, and then 14 feet more to the hill top. As showing the local variations in dip which may be looked for in mining these flat coals, it may be stated that this Kopp mine is dipping to the south-west and south decidedly, while the regular dip of the measures at the point is about north-west, and this abnormal dip is continued as far as the mine has been driven (about 80 yards).

At E. Luther's natural opening one and a half miles east of Troutville, one half mile above Pentz's mill, and thirty-five feet above the creek level, the coal measured:

Gray slates and dark slates,	3'
Black slate roof, thin bedded,	2 6"
Coal,	1 8
Floor, not seen.	

The coal seemed to dip to the south-west. The hill rises 80 feet above, but shows no marked bench.

On the Bell and Kramer property, one and a half miles south south-east of Troutville, coal has been opened up 69 feet (by barometer) above the creek. It measured as reported (for it has now fallen shut):

Black slate roof.	
Coal,	2' to 2' 1"
Slate,	1 4
Fire-clay, tough, plastic, thick.	

The coal is rising to the north-west.

Another bench is found at 136 feet above the creek, where, with a pile of black slate thrown out from a trial pit, there are numerous pieces of blue carbonate *iron ore.* From the appearance of the pieces the carbonate ore must be bedded in thin plates in the slates. The hillside rises one hundred feet higher, but without any marked bench. South of Troutville, on the Godfrey Weaver place, a bed of limestone is exposed. It is a fair-looking, dove-colored limestone, and, from its appearance when weathered, evidently contains considerable iron.

27. Huston Township.

This is a large area lying in the north-western corner of the county. It covers about one hundred square miles, a large portion of which is a wilderness of unimproved timber land.

The central line of the *Third coal basin* is approximately indicated by the alignment of the Low Grade Railroad.

Barren Measure rocks occupy the central part of the basin from near Winterburn south-west to Brady (Sandy) township, and I am not satisfied of the absence of these measures between Winterburn and Tyler's.

The "three-foot bed" opened at Winterburn may be one of the *Barren Measure coals*, and the same may be said of the openings made at Penfield, but at Tyler's the character of the measures is apparently very different, and I am inclined to recognize the Tyler coal as one of the Lower Productive beds. The Tyler bed can hardly be called a "four-foot bed," and is, moreover, quite sulphurous. The company have erected a washer and a bank of about thirty ovens; but, at the time of my visit, the bank was not being worked.

The bed lately opened in settlement north-west of Winterburn doubtless belongs to the Lower Productive measures. I did not recognize the Mahoning Sandstone at any point in this township. The apparent absence of this rock as a massive or coarse-grained sandstone, the wildness of the country, the small amount of prospecting that has been done, and the limited time I was able to devote to this area, have prevented me from defining the limits of the Barren measures with a satisfactory degree of accuracy. The local geology of this township must be defined in the future by a more thorough geological examination or by practical examinations with the pick and shovel.

[In Report H it is mentioned that—]

Near Tyler's station on the Low Grade Railroad, a coal is opened and worked to a small extent. It shows:—

Shales overlying.	
Carbonated clay slate roof, ...	3′ 0″ or more.
Coal, with small slate partings, not persistent, . .	3 0
Soft fire-clay floor.	

The coal in mining out shows sulphur balls in the irregular slate.

A specimen of this Tyler mine coal yielded, on analysis, (McCreath):—

"Water,	0.940
Volatile matter,	31.060
Fixed carbon,	61.563
Sulphur,	1.487
Ash,	4.950
	100.000

Coke, per cent, 68.00. Color of Ash, gray, with red tinge."

APPENDIX.

The Fire-clays of Clearfield County.

[The following description of the fire-clays of Clearfield county, in Mr. Platt's report H, is here reprinted in this report without change.]

The fire-clays of Clearfield county are opened and worked in the First and Second Coal Basins, along the line of the Tyrone and Clearfield railroad, at Sandy Ridge, Blue Ball, Woodland, and Clearfield.

The Sandy Ridge Fire-clay mines and works are at Sandy Ridge Station, on the Tyrone and Clearfield railroad, one mile north-west of the summit of the Allegheny mountain. Where measured, the clay showed:

Sandstone.	
Black slate,	1′
Coal,	0 1′
Fire-clay, worked,	5
Fire-clay, hard, not worked,	2 or more.

The hard fire-clay layer which is worked, ranges usually from 4 feet to 6 feet thick, averaging 5 feet or more; but ranges in places from 4 feet to 12 feet in thickness.

A small coal bed one foot thick is reported as showing 25 to 30 feet above the black slate layer of Fig. 60.

The clay worked is in three layers, and these are kept separate, the different qualities of these layers making them specially valuable for different purposes. The top layer is said to be adapted for furnace bottoms; the middle layer, the hard clay, is used for bricks, and the third layer for making tiles and the in-wall of furnaces. The hard sandy clay in the bottom is not worked.

Average specimens of these four layers of clay yielded, on analysis (McCreath):

1. Top layer. 2. Second layer. 3. Third layer. 4. Bottom layer.	1.	2.	3.	4.
Silica,	45.650	44.950	45.820	74.950
Alumina,	34.730	37.750	35.960	15.940
Oxide of iron,	3.546	2.700	3.330	1.899
Lime,	.112	.302	.112	.106
Magnesia,	.619	.216	.573	.407
Alkalies,	5.750	.985	4.130	1.756
Water,	9.650	13.050	10.130	4.885
	100.057	99.953	100.045	99.943

A glance at the above table of analyses shows why the bottom layer is not worked.

An analysis of Sandy Ridge fire-clay, made in 1870, by Mr. McCreath, for the Pennsylvania Steel Company, and published by permission of the president of that company, yielded:

Silica,	45.880
Alumina,	33.920
Oxide of iron,	4.680
Lime,	.160
Magnesia,	.750
Alkalies,	4.643
Water,	10.370
	100.403

The above analysis agrees very closely with the average of the three analyses of the top, second, and third clay layers.

"Clay No. 1 (top layer) is massive, of pearl color, has a soapy feel, and the outside of the lumps slightly fibrous.

"Clay No. 2 (second layer) is compact, massive, has grayish color, with bluish tint on fresh surface.

"Clay No. 3 (third layer) is compact, of pearl gray color, and breaks in plates, and contains small scales of mica.

"Clay No. 4 (bottom layer) is compact, of pearl gray color, uneven fracture, and containing small scales of mica."

The works have a capacity of 16,000 bricks a day, running full time, and the material shipped from them bears a deservedly high name.

These clays rest almost directly upon the Pottsville conglomerate (XII) and are therefore at the bottom of the lower productive coal measures. The clays run regularly, vary-

ing of course in thickness, but keeping their general character and average size with sufficient constancy.

With the average dip to the north-west found at this point the clay deposit sinks steadily down and passes beneath water level of the Moshannon creek. No fire-clay is worked of those underlying the different coal beds of the first basin.

The next point where fire-clay is opened and worked is on the land of the Harrisburg Fire Brick Company, about two and a half to three miles west of Blue Ball station, on the Tyrone and Clearfield railroad, and 400 feet (by barometer) above the railroad level. The opening shows:

Surface and clay,	2′	
Impure fire-clay,	7	
Hard fire-clay,	4	10″
Soft fire-clay underlying.		
Massive white sandstone.		

Where exposed in a shaft north-east of the open work, the clays show:

Surface and loose stuff,	6′	
Coal,	0	2″
Soft fire-clay,	6	
Hard fire-clay,	7	

Another shaft gave:

Surface and loose stuff,	6	
Coal smut,	0	2
Fire-clay,	6	
Dark fire-clay,	1	6
Soft fire-clay,	0	4
Hard fire-clay,	3	
Brown sandstone,	0	2
Massive sandstone, hard, white, in bottom.		

These clays are in three layers, called respectively the upper layer, or "shell clay;" the middle layer, or "block clay," called the best of the three; the lower layer, or "flag clay."

Average specimens of these three clay layers, forwarded for analysis, yielded (S. A. Ford):

	Upper layer.	*Middle.*	*Bottom.*
Silica,	42.700	43.350	44.550
Alumina,	37.600	37.550	39.000
Protoxide of iron,	3 385	2.145	1.440
Titanic acid,	2.500	2.825	1.700
Lime,	.112	.084	.028
Magnesia,	.270	.234	.072
Alkalies,	.730	.235	.530
Water and organic matter,	13.840	14.170	13.660
	100.137	100.593	100.980

The upper layer is hard, compact, and of a dark bluish gray color.

The middle layer is hard, compact, with a dark pearl gray color, with conchoidal fracture.

The lower layer is hard, compact, of a light pearl gray color, with conchoidal fracture.

The mine from which the above specimens were taken is extensively worked by the company. They have no works at Blue Ball, but forward the clay raw to the Harrisburg Fire Brick Works, where it is manufactured into bricks. The works have a capacity of about 1,500,000 bricks per annum; easily increasable to double that amount.

The bricks are used for heating and puddling furnaces, and for blast furnace linings; chiefly in the Schuylkill, Susquehanna, and Cumberland valleys.

Moreover, the raw clay is shipped to Pittsburg to the Fire Brick Works there, and is used for making pots for the glass works. It is also shipped east, though not extensively, to Fire Brick Works.

The analysis of this clay shows it superior to the other Clearfield county clays examined; though the analysis of small specimens must always afford an only partially accurate comparison.

The bricks, however, bear a very high reputation, and the clay is in demand.

It will be noticed that these clays carry an average two and a half per cent of *titanic acid*, one of the Clearfield clays showing one half per cent of titanic acid, and the others none. It is an interesting question how far the superior heat-resisting qualities of fire bricks are affected by the presence in quantity of this rather unusual constituent.

These clays in their floor, cover, character, and size, resemble strongly the Sandy Ridge fire-clays, and give every evidence of being the same bed, altered but little in its passage underground from the Sandy Ridge mine, on the crest of the Allegheny mountain, to this Blue Ball mine, where the clay is again raised high up and comes out to daylight near the summit of the First anticlinal sub-axis.

There is a bed of fire-clay struck in the wells at Wallaceton, and from the measures exposed in the vicinity it is very possible, and even probable, that is the same bed as that exposed at Sandy Ridge and Blue Ball. But if so it seems to have lost, temporarily, both in size and character.

The Hope fire-clay works are at Woodland station, on the Tyrone and Clearfield railroad, six miles east of Clearfield. The mines are opened on the south side of Roaring Run Brook, about 40 feet above the stream. Massive sandstone makes the country rock between the stream level and the floor of the mine. The hill rises 50 feet above, covered on the surface with sandstone lumps, usually of moderate size, without any pebble rock conglomerate.

The working face of clay exposed measured an average of about five feet of hard, good-looking clay, with softer or more impure fire-clay in roof and floor. While a part of this five-foot clay occasionally deteriorated temporarily in character, yet the general average of the bed, both in size and quality, is sustained with much regularity.

Another drift, about 100 yards away, shows nearly the same thing, but with perhaps more of the inferior, and less of the valuable, clay showing in the working face.

An average specimen of the clay forwarded for analysis yielded (McCreath):

Silica,	46.250
Alumina,	37.500
Protoxide of iron,	1.935
Lime,	.168
Magnesia,	.126
Alkalies,	1.115
Water and organic matter,	13.540
	100.634

The clay is hard, compact, of a pearl gray color, and somewhat slaty structure.

The Woodland fire-clay works are on the Tyrone and Clearfield railroad, about three fourths of a mile west of Woodland Station. The mine is opened on the north side of Roaring Run brook, and shows 4 to 5 feet of good hard clay in places, but varying both much and rapidly, the workable layer in some places being pinched down very small. A small 3 or 4 inch coal overlies the workable clay layer, and on top of the coal there come in several feet of darker and impure fire-clay.

An average specimen forwarded for analysis yielded (S. A. Ford):

Silica,	45.450
Alumina,	36.125
Protoxide of iron,	2.275
Lime,	.168
Magnesia,	.342
Alkalies,	1.290
Water and organic matter,	13.730
	99.380

The clay is hard, compact, of pearl gray color, and slaty structure.

These openings last mentioned (Hope and Woodland) are apparently on the same bed; and there is every probability that this bed is the same as the one worked at Sandy Ridge and Blue Ball. It may be said that this fire-clay deposit, resting on top of the seral conglomerate and below the coals of the Lower Productive coal measures, is widely distributed and well known in Pennsylvania.

A fire-clay has been recently opened about three fourths of a mile north-west of the Woodland Station, on the Tyrone and Clearfield railroad. It is the same fire-clay as that opened and already described at the Hope and Woodland fire-clay mines, but the three inch coal seam which is present at those openings is entirely wanting in this trial shaft.

About one half mile south-east of the Hope mine the bed has been opened again, and here the bed is fossiliferous, and the coal has thickened out to 5 inches.

Two average specimens yielded on analysis (McCreath):

	Hard clay No. 1.	*Soft clay No. 2.*
Silica,	45.230	46.180
Alumina,	38.030	36.880
Oxide of iron,	1.980	2.250
Lime,	.163	.173
Magnesia,	.237	.317
Alkalies,	.830	2.760
Water,	13.605	11.580

Clay No. 1 is hard and compact, with slaty color.

Clay No. 2 is compact, of pearl gray color, comparatively soft.

At Barrett Station, on the Tyrone and Clearfield railroad, a fire-clay was opened some years ago, 95 feet (by barometer) above the railroad level, but was never worked for shipment to market. The clay was apparently of uncertain quantity, and had fallen off in quality.

Fire-clay works have recently been established at the town of Clearfield.* The mine opening is made in the hill side, east of the railroad depot, at the north end of the town. The section showing on the crop where opened is a curious exaggeration of an ordinary fire-clay deposit. It is as follows, beginning at the top:

Coal,		6″ to 9″
Impure fire-clay, with shales intermingled,	7′	0
Coal,	0	6
Hard fire-clay, sandy near the top,	8	0
Fire-clay,	2	0
Fire-clay,	4	0
Fire-clay, with nodular iron ore balls,	2	0
Fire-clay, some few iron ore lumps,	4	0
Carbonate iron ore balls,	0	6
Hard fire-clay, impure,	3	0
Sandstone,	7	6
Fire-clay and black slate,	2	6
Black slate, clayey,	3	6
Fire-clay,	6	0
Coal, Peacock,	0	6

* Written in 1874.

Where the clay was opened in the mine for working at the time of the examination (July, 1874,) it showed:

Top clay and sandstone,	4	0''
Smooth clay,	2	6
Coarse plastic clay,	2	6
Coarse plastic clay,	1	6
Hard clay, used for terra cotta ware,	4	1
Clay,	2	3
Carbonate iron ore balls in clay.		

The bottom clay layer of this section shows great irregularity, making a waving floor, the layers above, however, being more smooth and even.

The different clay layers showed much diversity in character, some being quite sandy, while interleaved layers were evidently of excellent quality. The prevailing character of the clay, however, was over silicious, as the analyses given below plainly show.

Since the examination the valuable layers of this clay mass have apparently either diminished in size or retrograded in quality, as the mine is now abandoned, and clay for the works is brought from near Woodland Station, on the Tyrone and Clearfield Railroad.

A full suite of specimens of this Clearfield fire-clay, forwarded to the Laboratory of the Survey in Harrisburg, yielded on analysis (specimens 1 and 2 by A. S. McCreath, and specimens 3, 4, 5, 6, 7, and 8 by S. A. Ford):

	1.	2.	3.	4.	5.	6.	7.	8.
Silica,	60.130	64 850	50.150	67 950	57.375	53.560	61 000	51.360
Alumina,	25.710	23.770	35.600	20.150	27.005	28.820	25.800	31.250
Protoxide of iron,	2.371	1.218	.845	1 980	2 549	2.243	2 347	1 936
Bisulphide of iron,	.067	.032	.	. .	.033	.135	.064	.748
Titanic acid,	..	...	..		..			.500
Lime,	.117	.190	.112	.084	.112	.431	trace.	.061
Magnesia,	.663	.122	.160	.216	.465	.605	.530	.260
Alkalies,	3.490	.345	.070	2.045	3.170	1.800	2.800	.035
Sulphuric acid,	.191	.280			...	.809	.379	.381
Water,	7.280	9.560	13.610	6.580	8.305	11.406	7.792	12.832
	100.019	100.367	100.547	99.005	99.514	99.869	100.712	99.363

These specimens were selected by the superintendent of the works from the fire-clay bed thus:

No. 1,	2′	thick.
No. 2,	2	"
No. 3,	4	"
No. 4,	2	"
No. 5,	2	"
No. 6,	2	"
No. 7,	4	"
No. 8,	2	"

Iron ore balls in bottom.

No. 1, is hard, compact, and of a slaty color.

No. 2, is hard, compact, and of a slaty color.

No. 3, is hard, compact, and of a dark olive color, fracture conchoidal, and structure slightly laminated.

No. 4, is hard, compact, and of a dark gray color.

No. 5, is hard, compact, unctuous, with gray color and slaty structure.

No. 6, is hard, compact, and slaty, and of a slightly bluish color.

No. 7, is hard, brittle, unctuous, and of a gray color.

No. 8, is hard, compact, of a light pearl gray color, with conchoidal fracture.

Tests were made in the summer of 1874, at the Clearfield fire-clay works, of the standing up power of several well-known fire bricks. The bricks tested were the Mount Savage, Dunkirk (Scotch), Woodland, Clearfield county, and two bricks made from the best interleaved layers of clay in the mine of the Clearfield brick works. The temperature was that of molten steel. The Mount Savage brick, as might be expected from its high reputation, bore the test, but gave some signs of yielding.

The Dunkirk brick stood the test admirably, giving but slight signs of yielding, and the Clearfield bricks bore the test equally well.

The fire-brick from the Woodland works was of good quality, but showed signs of yielding.

The crown of the kiln, in which the experiment was made, composed of Clearfield brick, was intact at the end of the test, showing great standing up power.

It will be remembered that two points of great swelling in size of the fire-clay beds on Clearfield creek have already

been noted, though the quality in neither case seemed to be of the first order. It is difficult to locate exactly in its geological position this mass of fire-clay at Clearfield. From the record of the old oil boring, already given, in which only one small six inch coal was found under this clay, it would seem to be safe to assign to it the same geological horizon at the Sandy Ridge and Blue Ball fire-clays. But the measures of the Second Coal Basin, here exposed at Clearfield, are very difficult of identification. The absence of massive sandstone, the numerous and invariably moderate sized coals, the great development of clays and clay slates, render it difficult to bring the measuses exposed here in harmony with those showing in the vertical sections made at Osceola or Snow Shoe, in the Eastern sub-division of the First Coal Basin, or at Karthaus, in the Western sub-division of the same basin.

This clay deposit is continuous for a distance, but was never observed in any other place in so exaggerated a condition as where showing at the Clearfield brick works.

In order to facilitate a rapid comparison of these fire-clays with some well known and valuable clays, the analyses which have been given in describing the fire-clay mines are grouped below into tabular form, taken from the report of Mr. McCreath, Chemical assistant to the Geological Survey of Pennsylvania; and below that a table of analyses of some of the best English fire-clays, the analyses being made by Mr. Abel, F. R. S., Chemist to the English War Department; the table of English fire-clays, as it stands, being taken from a valuable paper on fire-bricks by Lieut. Grover, of the Royal Engineer Corps. It is not intended to discuss the question of fire-bricks, but only to afford opportunity for comparison, and to state some few conclusions, Lieut. Grover's paper being freely drawn upon, verbatim.

With these tables there are also given two analyses of good clays from New Jersey, taken from the New Jersey Geological Report of 1868.

The Survey has necessarily confined itself in this report

to a statement of the analyses of the fire-clays examined, there having been neither time nor opportunity for a more elaborate examination. But during the present year it is proposed to carry out a series of practical tests of the standing up power of these clays given above, together with other valuable clays in the State, testing at the same time, for purposes of comparison, well known clays from other States and from England. These results, conveniently tabulated, must prove of value.

Analyses of Clearfield Fire-clays.

		Silica.	Alumina.	Protoxide of Iron.	Titanic Acid.	Bisulphide of Iron.	Lime.	Magnesia.	Sulphuric Acid.	Alkalies.	Water, &c.	Total.
Sandy Ridge,	1.	44.950	37.750	2.700	. . .	. .	.302	.216	.075	.985	13.050	100.028
	2.	45.650	34.730	3 546	. . . .	. . .	.112	.619	.165	5 750	9.650	100 222
	3.	45 820	35 950	3.330	. . .	. . .	.112	.573	.	4.130	10.130	100.045
	4.	74 950	15.940	1.899		. . .	.108	.407	.050	1.756	4.835	99.993
Blue Ball,	1.	42.700	37 600	2.385	2.500	. . .	.112	.270	.	.730	13 840	100 137
	2.	43 350	37 550	2.145	2.825	. . .	.084	.234	.	.235	14.170	100.593
	3.	44.550	39.000	1.440	1.700	.	.028	.072	.	.530	13.660	100 980
Clearfield	1.	60.130	25.710	2.371	. . . .	.067	.117	.663	.191	3.490	7.280	100 019
	2.	64 850	23.770	1.218	. . .	.032	.190	.122	.280	.345	9.560	100.367
	3	50.150	35.600	.845	. . . .	.	.112	.160		.070	13.610	100.547
	4.	67.950	20.150	1.980	. . . .		.084	.216	. .	2.045	6.580	99.005
	5.	57.875	27.005	2.549	. . . .	.033	.112	.465	.	3.170	8.305	99.514
	6.	53.560	28.820	2 243	. . .	.135	.431	.605	.869	1.800	11.401	99.869
	7.	61 000	25.800	2.347	. .	.064	Trace	.530	.379	2.800	7.792	99.712
	8.	51.360	31.250	1.936	.509	.748	.061	.260	.381	.035	12.382	99.363
Woodl'nd Station,	1.	46 180	36.880	2.250	. . .	. .	.173	.317	.009	2.780	11.580	100 149
	2.	45 230	33 030	1.980	. . . .	. . .	.163	.237	.013	.830	13.605	100.088
	3.	46 250	37.500	1.935	. . . .	. . .	.168	.126	.	1.115	13.540	100.634
	4.	45.450	36.125	2.275	. . . .	. . .	.168	.342	. .	1.290	13.730	99.380

Prof. George H. Cook, in his report of the Geology of New Jersey, (1868,) gives the following as analyses of two good specimens of New Jersey clays:

	White clay, near South Amboy.	*White clay, Trenton.*
Silica,	43.200	45.300
Alumina,	39.710	37.100
Zirconia,	1.400	1.400
Potash,	.370	1.300
Lime,	——	.170
Magnesia,	——	.220
Peroxide of iron,	.740	1.300
Water,	14.250	13.400
	99.670	100.190

English Fire-clays.

	Silica.	*Alumina.*	*Peroxide of Iron.*	*Alkalies, waste, &c.*
Stourbridge,	65.650	26.590	5.710	2.050
Do.	67.000	25.800	4.900	2.300
Do.	66.470	26.260	6.630	.640
Do.	58.480	35.780	3.020	2.720
Do.	63.400	31.700	3.000	1.900
New Castle,	59.800	27.300	6.900	6.000
Do.	63.500	27.600	6.400	2.500
Burton-on-Trent,	56.630	35.310	2.990	5.170
Wortley,	65.200	29.690	3.070	2.040
Poole,	68.600	23.600	4.700	3.100
Plympton,	75.890	21.610	1.960	.540
Do.	76.700	20.100	1.700	1.500
Hedgely,	84.650	8.850	4.250	2.250
Holytown,	59.480	31.450	6.900	2.170
Dinas,	96.200	2.000	.280	1.700
Kilmarnock,	59.100	35.760	2.500	2.640
Glenboig,	62.500	34.000	2.700	.800

These bricks have been tested practically at the Royal Arsenal furnaces, and the results, in Lieut. Grover's judgment, justify the conclusion that the refractory values of fire-bricks vary inversely with the amount of iron contained in them, and as a general rule the presence of six per cent. of peroxide of iron, warrants the absolute rejection of a fire-brick. This component usually takes the form of little black specks or mottled particles which are embedded in the material, and can be plainly detected upon breaking the brick.

Clays proper are chemical compounds, occurring under different phases in numerous geological formations, and consisting of hydrated silicates of alumina, either alone or in combination with silicates of potash, soda, lime, magnesia, iron, manganese, &c.

The so-called fire-clays owe their refractory properties to a variable absence—differing, that is to say, in different clays—of lime, oxide of iron, and the alkalies of magnesia, potassa, and soda. In refractory bricks, formed of baked fire-clay, the silica may be considered as a passive ingredient, acting mechanically to prevent excessive contraction, whilst the alumina forms the cement which binds the particles together.

The essential qualities of a good fire-brick may be classified as follows: Infusibility, regularity of shape, uniformity of composition, facility for cutting, strength, and cheapness.

Infusibility seems to forbid in the brick's composition so much as even five per cent of peroxide of iron, or three per cent of combined soda, lime, potassa, and magnesia. Generally speaking, a fire-brick should contain either silica or alumina in excess, according as it is intended for exposure to extreme heat, or for a possible contact with metallic oxides, which would exert a chemical re-action, decomposing it and acting as a flux. Thus, in theory, the arches of a furnace should be built of silicious bricks; its sides, bridge, and neck of aluminous bricks. Dr. Percy considers that to boast properly of the quality of infusibility, a fire-brick must well resist sudden and great extremes of heat, it must support considerable pressure at a high temperature without crumbling; it should not melt or soften in a sensible degree by exposure to intense heat long and uninterruptedly continued; and it should withstand, as far as practicable, the corrosive action of slags rich in protoxide of iron. He recommends as a test that the fire-clay should be formed into small sharp-edged prisms, which, on being inclosed in a covered crucible and subjected to an extreme temperature in an air or blast furnace, would denote a very high degree of refractoriness if the edges remained sharp, an incipient fusion of the material if the edges are rounded, and a thoroughly inferior quality of the fire-clay if the prisms were melted down.

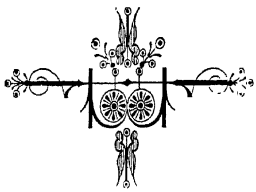
Strength is obviously necessary to enable the bricks to avoid breakage in transport, and to withstand the pressure and cross strains to which they will be subjected when built into the work. It is stated by Rankine that the resistance to crushing by a direct thrust, the bricks being set on edge in an hydraulic press, is per square inch in weak red bricks, from 550 to 800 pounds; in strong red bricks, 1,100 pounds; in fire bricks, 1,700 pounds. But experiments made at the Royal Arsenal upon isolated cubes of one and a half inch side, cut from fire-brick "soaps," and placed between small squares of sheet lead, gave the following results.

	Cracking weight, lbs. per sq. inch.	*Crushing weight, lbs. per sq. inch.*
Stourbridge,	1,478	2,400
Stourbridge,	1,156	2,245
New Castle,	889	1,512
Plympton,	1,689	2,666
Dinas,	1,123	1,288
Kilmarnock,	2,134	3,378
Glenboig,	1,067	1,556

And the average crushing weight of ordinary stock bricks was found to be from 666 pounds to 866 pounds per square inch. Hence, all fire-bricks known may be said to have a strength far in excess of that which would ever be required of them in actual work.

Bricks with a high percentage of silica, though having a high refractory power, should not be exposed to the action of slags rich in metallic oxides, or to the fumes from lead ores, or to proximity with alkaline substances generally.

INDEX.



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Secretary of Internal Affairs,
Harrisburg, Pa.

October 4, 1883.